The Distribution of Landings of British Columbia Salmon in Relation to Size of the Commercial Fishing Fleet, 1967-1981. V. Coho Salmon

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ABSTRACT

Beacham, T. D. 1984. The distribution of landings of British Columbia salmon in relation to the size of the commercial fishing fleet, 1967-1981. V. Coho salmon. Can. Tech. Rep. Fish. Aquat. Sci. 1304: 71 p.

The distribution of landings of coho salmon in relation to the size of the commercial fishing fleet was investigated on an annual basis during 1967-1981. An average of 1523 gillnetters accounted for 90% of the total landings in any year. Seventy-five percent of the vessels participating in the gillnet fishery landed less than 200 coho salmon annually. The top 50% of the vessels participating in the gillnet fishery accounted for 88% of the total annual landings. An average of 291 purse seiners accounted for 90% of the landings, and 46% of the seiners landed less than 500 pieces annually. The top 50% of the seiners accounted for 85% of the total annual landings. An average of 1334 trollers accounted for 90% of the total annual landings of coho salmon. About 75% of all vessels participating in the troll fishery for coho salmon landed less than 1000 pieces annually. The top 50% of the vessels that landed troll-caught coho salmon accounted for 92% of the total annual landings.

Key words: British Columbia, catch, coho salmon, exploitation, gillnet, seine, troll.

RÉSUMÉ

Beacham, T. D. 1984. The distribution of landings of British Columbia salmon in relation to the size of the commercial fishing fleet, 1967-1981. V. Coho salmon. Can. Tech. Rep. Fish. Aquat. Sci. 1304: 71 p.

On a étudié la distribution annuelle des débarquements de saumon coho, de 1967, à 1981, en fonction de la taille de la flotille de pêche commerciale. Chaque année, 90% des débarquements ont été effectués, en moyenne, par 1,523 bateaux de pêches au filets maillants. De ces bateaux, 75% ont débarqué moins de 200 saumons cohos annuellement et les premiers 50% ont effectué 88% des prises totales annuelles. Une moyenne de 291 senneurs, dont 46% ont débarqué moins de 500 poissons annuellement, one capturé 90% des prises. Les premiers 50% de ces senneurs ont pêché 85% des prises totales annuelles. En moyenne, 1,334 bateaux de pêche à la traîne ont effectué 90% des débarquements annuels de saumon coho. Environ 75% de tous les bateaux de pêche à la traîine ont capturé moins de 1,000 poissons annuellement et les premiers 50% se sont approprié 92% des prises totales annuelles.

Mots-clés: Colombie-Britannique, prise, saumon coho, exploitation, filet maillant, senne, ligne traînante

INTRODUCTION

The British Columbia commercial fishing fleet for salmon is currently too large, given the amount of salmon to be harvested and the efficiency of the fleet to do so. A commission on Pacific fisheries policy suggested that the salmon fleet be reduced to half of its present capacity over a 10-year period (Pearse 1982). This reduction in fleet capacity was suggested to be accomplished by a buy-back program. In an evaluation of a buy-back program, a committee was established to recommend in part the number of vessels that should be present in the fishery after the buy-back program is completed. The recommendation for the salmon fleet was for 400 seiners, 1467 trollers, and 2208 gillnet plus gillnet/troll combination vessels (Cruickshank et al. 1982). This would represent a 25% decrease in the number of seiners (from 532 to 400), 12% for trollers (from 1667 to 1467), and 12% from gillnet plus gillnet/troll combination vessels (from 2508 to 2208). However, it is uncertain what the degree of redistribution of the landings would be if the suggested number of vessels were removed from the fleet.

Incomes are distributed non-uniformly among fishermen (Sinclair 1978). Landings of salmon may also be distributed non-uniformly among different vessels participating in the salmon fishery. The present report details the distribution of landings of coho salmon (Uncorhynchus kisutch) in relation to the size of the commercial fishing fleet and indicates the degree of redistribution of the landings that may be expected when decisions on fleet size are made.

An analysis was conducted in order to determine the distribution of catch in relation to the number of commercial fishing vessels for each species of Pacific salmon and for all species combined on a weight basis. This analysis was conducted for each of the major gear components in the British Columbia salmon fishery (gillnet, seine, and troll). When the distribution of catch of Pacific salmon in relation to the size of the commercial fleet is known, decisions can be made on the level to which the fleet could be reduced. The present report deals with the distribution of landings of coho salmon during 1967-1981 in relation to the number of commercial fishing vessels in British Columbia and it is the fifth in a series of reports on the distribution of landings of Pacific salmon.

MATERIALS AND METHODS

The information upon which the distribution of landings in relation to the size of the commercial fishing fleet is determined is derived from sales-slips. Wong (1983) has described the procedure used in recording and editing the information contained on the sales-slip. Summarized briefly, sales-slips are generated when the catch is delivered for processing or sold, and information on the commercial fishing vessel (CFV) license number, gear, area, period, and weight or numbers of species caught is recorded.

Sales-slips lacking numbers of salmon landed but containing the weight landed are adjusted for numbers by dividing the weight by the mean weight of the particular species, area, and gear that are applicable.

The analysis in the present study depended upon compiling the annual landings by species for each commercial fishing vessel in the three major gear classifications: purse seiner, gillnetter, and troller. This should be confidential information, so that, as outlined by Wong (1983), original commercial fishing vessel license numbers are converted to different codes by a standard method each year, so that it is not possible to relate catches to a specific vessel without authorization. The analysis for this report used solely the transformed license numbers.

The analysis of the sales-slips revealed that in some instances, there would be only 1 sales-slip for a particular license number in one of the three gear classes in a year. These were assumed to be errors in recording the license number, and were deleted in the subsequent description of the distribution of the catch. The distribution of catch was summarized in two ways, the first being by the number of vessels in a particular gear class, and the second by the percentage of vessels in a particular gear class. The number of vessels that landed salmon in a particular gear class was not constant during 1967-1981, so that both methods were used to describe the catch distribution.

Landings from combination vessels (gillnet and troll gear) were assigned to the gear used to catch the salmon sold at the time that the sales-slip was generated. Landings from a combination vessel would thus appear in both the troll and gillnet gear classes as appropriate.

The salmon sales-slip data tapes upon which the present analysis is based were derived from Wong (1983). The number of purse seiners recorded landing coho salmon in 1980 and 1981 was greater than the number of licensed vessels. It was assumed that errors were made in recording the gear of some commercial fishing vessel license numbers so that the maximum number of purse seiners in 1980 and 1981 was set at the number of licenses (532). For the analysis in this report, landings of coho salmon by purse seine vessels were arranged in descending order and landings from the 533rd vessel onwards were deleted. This removed those vessels with the smallest annual landings of coho salmon.

The top 200 vessels in terms of landings for a particular species were recorded annually for trollers and gillnetters during 1967-1981. The top 100 seiners were recorded annually during 1969-1981. When the top vessels were identified in a particular year, it was possible to examine how many were also in the top category in previous and subsequent years. For example, once the top 200 gillnetters for coho salmon had been identified in 1975, it was possible to examine how many of these same vessels were in the top 200 gillnetters for coho salmon in 1973 or 1981. This analysis was conducted in order to determine whether or not some vessels were successful on a continuing basis.

The analysis of distribution of landings in relation to the number of vessels in each fleet component first proceeded by determining annual landings for each species for each vessel in the three gear categories.

Vessels were then sorted in descending order based upon the size of the landings for each species. Once the total catch and the total number of vessels that participated in the fishery for each species were determined, it was then possible to calculate the proportion of the catch that was taken by different numbers of vessels and also different proportions of the fleet. The number and percentage of vessels that landed different numbers of salmon were also calculated.

RESULTS

GILLNET COMPONENT

The landings of coho salmon by gillnetters have ranged from 173 thousand pieces in 1981 to 1.04 million pieces in 1968 (Table 1). The gillnet share of the total landings of coho salmon has declined relative to the other gears when landings are considered on a coast-wide basis. Prior to 1970 gillnetters accounted for approximately 20% of the coast-wide landings, but their share of the total landings declined to about 6% in 1981.

The distribution of total landings of coho salmon in relation to the number of vessels participating in the gillnet fishery was examined on an annual basis during 1967-1981 (Appendix A, Tables A1-A15). This 15-year distribution of the landings in relation to the number of vessels in the fishery is summarized in Figure 1. An average of 1523 vessels accounted for 90% of the total landings in any year. When landings exceeded 1 million pieces in 1968, 90% of the landings were accounted for by 1639 vessels (Table 2). The smallest gillnet landings of coho salmon were recorded in 1981, and in that year 1146 vessels accounted for 90% of the total landings. The top 1109 vessels accounted for an average of 80% of the total landings in any year (Table 2). The increase in landings in moving from 80 to 90% of the total landings was accompanied by an increase in the number of vessels by 37%. In examining the number of vessels that account for 100% of the landings as compared with 90%, the number increased 93% from 1523 to 2947 vessels.

The frequency of total landings per vessel was also investigated on an annual basis. An average of 75% of the vessels participating in the gillnet fishery for coho salmon landed less than 200 coho salmon annually during 1967-1981 (Table 3). About 4% of the vessels landed more than 600 coho salmon annually. The poorest 75% of the vessels participating in the gillnet fishery land less than 200 coho salmon each in most years. The top 50% of the vessels participating in the gillnet fishery during 1967-1981 accounted for an average of 88% of the total annual landings (Table 4). Recall that 90% of the total gillnet landings of coho salmon was accounted for by 1523 vessels.

The annual repeatability of success in landing coho salmon was examined by identifying the top 200 gillnetters in each year during 1967-1981 and tallying how many of these 200 were in the top 200 in all other years. The results are illustrated in Table 5. With an average of 2947 vessels in

the fishery and under the assumption of a random distribution of the top 200 vessels in all years except the one in which they were the top 200 vessels, one would expect an average of (200/2947) x 200 = 14 vessels to appear by chance. If 21 or more appear, there is a significant statistical association ($x^2 = 3.84$, $P < 0.05$), which indicates that vessels successful in one year were also successful in previous and successive years. For example, if one examines the top 200 vessels in 1981, there were a significant number of these vessels that were also in the top 200 vessels during 1969-1981 (Table 5). This analysis indicates that successful coho salmon gillnet vessels tend to be successful on a continuing basis.

SEINE COMPONENT

The landings of coho salmon by purse seiners have ranged from 173 thousand pieces in 1969 to 678 thousand pieces in 1977 (Table 1). The proportion of the total landings accounted for by purse seiners has ranged between 10 to 20% during 1967-1981.

The distribution of total landings of coho salmon in relation to the number of purse seiners was examined on an annual basis during 1967-1981 (Appendix B, Tables B1-B15). The distribution of the landings in relation to the number of purse seiners participating in the fishery is summarized in Figure 2. On an average basis between 1967 and 1981, about 291 purse seiners accounted for 90% of the total landings in any year. However, in 1969, when 173 thousand pieces were landed, 225 vessels accounted for 90% of the total landings, and in 1977, when 678 thousand pieces of coho salmon were landed by purse seiners, 291 vessels accounted for 90% of the total (Table 6). An average of 209 vessels accounted for 80% of the total landings in any year. In moving from 80 to 90% of the total landings of coho salmon, the number of vessels increased from 209 to 291. This increase in catch was accounted for by a 39% increase in the number of vessels. In examining the number of vessels that account for 100% of the landings, the number was an average of 505, an increase of 74% over the number of vessels accounting for 90% of the landings.

The frequency of total landings per vessel was also investigated on an annual basis. About 46% of the purse seiners participating in the coho salmon fishery landed less than 500 pieces annually (Table 7). An average of about 7% of the vessels landed in excess of 3000 pieces annually. The top 50% of the vessels participating in the fishery during 1967-1981 accounted for an average of 85% of the total annual landings (Table 4). Recall that 80% of the total purse seine landings of coho salmon was previously noted to be accounted for by the top 209 purse seiners.

The annual repeatability of success in landing coho salmon in the purse seine fishery was examined by identifying the top 100 seiners in each year during 1969-1981 and tallying how many of these 100 were in the top 100 in all other years (Table 8). Using an average of 505 vessels in the fishery, one would expect, under the assumption of a random distribution of the top 100 vessels in all years except the one in which they were the top 100 vessels, that an average of (100/505) x 100 = 20 vessels to appear by chance. If 29 or

more vessels appear, this indicates that vessels successful in one year (the diagonal of 100s in Table 9) were also successful in the year for which 29 or more vessels are counted ($x^2 = 3.84$, $P < 0.05$). For example, the top 100 seiners for coho salmon in 1980 were also more successful for coho salmon during 1973-1981 than one would expect by chance (Table 9). There is some evidence to indicate that successful coho salmon purse seine vessels tend to be successful for a range of years.

TROLL COMPONENT

Landings of troll-caught coho salmon have ranged between 1.4 million pieces (1975) and 3.5 million pieces (1971) (Table 1). Trollers generally accounted for in excess of 65% of the total commercial landings during 1967-1981.

The distribution of total landings of coho salmon in relation to the number of vessels that used troll gear to land coho salmon was examined on an annual basis during 1967-1981 (Appendix C, Tables C1-C15). The distribution of landings of coho salmon in relation to the number of vessels using troll gear that participated in the fishery is summarized in Fig. 3. On an average basis between 1967 and 1981, about 1334 trollers accounted for 90% of the landings in any year (Table 9). Trollers had the greatest landing of coho salmon in any year during 1967-1981 in 1971, and in that year, 1446 vessels accounted for 90% of the total landings. The best 1083 trollers accounted for 80% of the landings in 1971. On an average basis between 1967 and 1981, the top 983 vessels accounted for 80% of the landings in any year. In increasing from 80 to 90% of the total troll-caught landings of coho salmon, the average number of vessels that accounted for the catch increased from 983 to 1334, an increase of 36%. An average of 2905 vessels accounted for 100% of troll-caught coho salmon, an increase of 118% over the number of vessels accounting for 90% of the landings.

The frequency of total landings per vessel was also investigated on an annual basis during 1967-1981. An average of 136 vessels landed more than 3000 coho salmon annually (Table 10). Of the vessels that used troll gear to land coho salmon, about 58% of these vessels landed less than 500 troll-caught coho salmon annually. The top 50% of the vessels that landed troll-caught coho salmon during 1967-1981 accounted for an average of 92% of the total annual landings (Table 4).

The annual repeatability of success in landing coho salmon in the troll fishery was examined by identifying the top 200 vessels in each year during 1967-1981, and tallying how many of these 200 were in the top 200 in all other years (Table 11). Using an average of 2905 vessels in the fishery, one would expect, under the assumption of a random distribution of the top 200 vessels in all years except the one in which they were the top 200 vessels, that an average of (200 x 200/2905) = 14 vessels to appear by chance. If 21 or more vessels appear, this indicates that the vessels successful in one year (the diagonal of 200s in Table 11) were also successful in the year in which 21 or more vessels were counted ($x^2 = 3.84$, $P < 0.05$). For example, the top

200 trollers in 1981 were also more successful for coho salmon during 1969 to 1981 than one would expect by chance alone (Table 11). This analysis suggests that successful troll vessels for coho salmon tend to be successful for a number of years.

DISCUSSION

The number of vessels accounting for 90% of the harvest of British Columbia coho salmon under a similar management policy as was instituted during 1967-1981 was found to be about 1523 gillnet vessels, 291 purse seine vessels, and 1334 trollers. Reducing the size of the commercial fleet to the previously noted levels would not significantly reduce the overall landings of coho salmon nor the exploitation rates on the species. With less competition among vessels of each gear class under a reduced fleet size, the exploitation rate of an average vessel could increase to the extent that overall exploitation rates on coho salmon stocks could increase. Exploitation rates must necessarily continue to be regulated by restrictions on fishing time and locations.

The number of vessels of each gear class that the present analysis indicates would be sufficient to harvest British Columbia coho salmon is less than the recommendations of a British Columbia fleet rationalization committee of 2208 gillnetters, 400 seiners, and 1467 trollers (Cruickshank et al. 1982). The present analysis suggests that the number of seiners could be reduced by 45% (from 532 to 291), gillnetters and combination gillnet/troll vessels by 39% (from 2508 to 1523), and trollers by 20% (from 1667 to 1334) and the landings of coho salmon would not be significantly reduced. It is assumed that the least effective vessels would be removed from the fishery. The present analysis deals only with coho salmon landings, but the results for the other species are similar. For example, an average of 1320 gillnetters and 305 seiners accounted for 90% of the landings for each gear type of pink salmon in British Columbia during 1967-1981. An average of 1290 gillnetters and 290 seiners accounted for 90% of the landings for each gear type of chum salmon. An average of 1492 gillnetters, 299 seincers, and 1439 trollers accounted for 90% of the landings of chinook salmon for each gear (Beacham 1984a,b; unpublished data).

Reduction of fleet size to the levels suggested by the fleet rationalization committee (Cruickshank et al. 1982) were projected to result in rapid rises in income to the vessels remaining in the commercial fleet. The present analysis for coho salmon suggests that if the least efficient vessels are removed from the fleet, mean landings of coho salmon per vessel will not increase and thus mean gross income per vessel remaining in the fleet will not increase, as long as total catches do not increase and prices remain stable.

The present report outlines the number of vessels necessary to harvest British Columbia coho salmon in the commercial fleet if current management practices are continued and gear distributions of catch are

maintained. It does not consider the social implications of reduction of fleet size and these should be considered in the establishment of targets for a reduced size of the commercial salmon fleet in British Columbia.

ACKNOWLEDGMENTS

Mr. Fred Wong made available the data upon which the distribution of landings of salmon in relation to fleet size was determined. Mr. Bruce Bernard designed the computer software for the graphics in this report. Mr. Bernard's assistance in this project was invaluable, and the study could not have been conducted in its present form without his considerable talents.

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Table 1. Commercial landings (thousands of pieces) of coho salmon in British Columbia, 1967-1981.

Year	Gillnet	Seine	Troll
1967	754	400	2077
1968	1040	481	3482
1969	442	173	1761
1970	939	535	2423
1971	715	616	3457
1972	651	336	2368
1973	473	566	2483
1974	469	524	2700
1975	422	504	1405
1976	368	454	2876
1977	392	678	2246
1978	395	385	2569
1979	237	503	2905
1980	269	418	2754
1981	173	537	2111

Table 2. Number of gillnetters accounting for varying percentages of the total gillnet landings of coho salmon in British Columbia, 1967-1981.

Percent of total landings	Year															
	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1967-81
10	27	44	32	67	33	53	43	39	35	48	34	65	36	39	27	41
20	64	107	80	164	85	136	110	94	95	119	88	153	92	100	73	104
30	111	193	150	287	157	246	209	169	175	211	161	267	164	182	139	188
40	171	309	245	445	259	386	339	274	282	325	257	402	251	288	227	297
50	247	456	373	634	401	558	502	415	421	464	381	561	354	425	339	436
60	362	645	541	857	585	765	697	592	595	632	540	750	478	600	474	608
70	552	880	759	1125	824	1017	934	817	814	839	745	980	631	825	637	825
80	851	1189	1051	1473	1137	1335	1229	1111	1094	1103	1017	1266	826	1113	847	1109
90	1360	1639	1490	1978	1607	1782	1659	1531	1511	1479	1416	1657	1088	1509	1146	1523
100	3233	3291	3365	3691	3487	3449	2975	2976	2884	2708	2668	2638	2013	2681	2157	2947

Table 3. Frequencies (and percentage) of vessels landing coho salmon in British Columbia by gillnets, 1967-1981.

Catch interval (pieces)	Year							
	1967	1968	1969	1970	1971	1972	1973	1974
0-200	2523(78.0)	1836(55.8)	1718(80.8)	2091(56.7)	2397(68.7(	2260(65.5)	2200(73.9)	2258(75.9)
201-400	333(10.3)	697(21.2)	398(11.8)	865(23.4)	635(18.2)	783(22.7)	568(19.1)	470(15.8)
401-600	100(3.1)	346(10.5)	130(3.9)	420(11.4)	219(6.3)	231(6.7)	107(3.6)	116(3.9)
601-800	71(2.2)	154(4.7)	50(1.5)	145(3.9)	66(1.9)	91(2.6)	45(1.5)	62(2.1)
801-1000	53(1.6)	86(2.6)	22(0.7)	93(2.5)	55(1.6)	41(1.2)	34(1.1)	32(1.1)
1001-1200	48(1.5)	47(1.4)	16(0.5)	33(0.9)	38(1.1)	24(0.7)	9(0.3)	25(0.8)
1201-1400	32(1.0)	45(1.4)	13(0.4)	23(0.6)	27(0.8)	11(0.3)	9(0.3)	8(0.3)
1401-1600	17(0.5)	24(0.7)	3(0.1)	14(0.4)	13(0.4)	4(0.1)	1(0.0)	4(0.1)
1601-1800	21(0.6)	13(0.4)	1(0.0)	2(0.1)	12(0.3)	2(0.1)	2(0.1)	0(0.0)
1801-2000	13(0.4)	17(0.5)	1(0.0)	3(0.1)	10(0.3)	0(0.0)	0(0.0)	1(0.0)
2000+	22(0.7)	26(0.8)	3(0.1)	2(0.1)	15(0.4)	2(0.1)	0(0.0)	0(0.0)
Total	3233	3291	3365	3691	3487	3449	2975	2976

Catch interval (pieces)	Year							
	1975	1976	1977	1978	1979	1980	1981	1967-81
1-200	2228(77.3)	2133(78.8)	2128(79.8)	2071(78.5)	1837(91.3)	2402(89.6)	2009(93.1)	2206(74.9)
201-400	442(15.3)	436(16.1)	360(13.5)	469(17.8)	158(7.8)	218(8.1)	113(5.2)	463(15.7)
401-600	120(4.2)	103(3.8)	110(4.1)	84(3.2)	14(0.7)	48(1.8)	24(1.1)	145(4.9)
601-800	55(1.9)	23(0.8)	39(1.5)	12(0.5)	2(0.1)	9(0.3)	7(0.3)	55(1.9)
801-1000	17(0.6)	10(0.4)	19(0.7)	1(0.0)	1(0.0)	2(0.1)	3(0.2)	31(1.1)
1001-1200	7(0.2)	2(0.1)	2(0.1)	1(0.0)	0(0.0)	2(0.1)	1(0.1)	17(0.6)
1201-1400	8(0.3)	0(0.0)	7(0.3)	0(0.0)	1(0.0)	0(0.0)	0(0.0)	12(0.4)
1401-1600	3(0.1)	1(0.0)	1(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	6(0.2)
1601-1800	1(0.0)	0(0.0)	1(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	4(0.1)
1801-2000	2(0.1)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	3(0.1)
2000+	1(0.0)	0(0.0)	1(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	5(0.2)
Total	2884	2708	2668	2638	2013	2681	2157	2947

Table 4. Percentage of the total landings of coho salmon that the top 50% of the vessels participating in the fishery account for in each gear type.

Year	Gillnet	Seine	Troll
1967	93	91	94
1968	90	88	96
1969	92	88	93
1970	88	91	92
1971	92	92	93
1972	89	90	92
1973	86	89	92
1974	89	88	92
1975	89	90	92
1976	87	80	93
1977	88	85	89
1978	82	74	89
1979	87	80	89
1980	86	77	90
1981	88	79	91
Mean	88	85	92

Table 5. A measure of the repeatability of success of landing coho salmon by gillnetters. The top 200 gillnetters in terms of number of coho salmon landed were identified each year (diagonal in table). The number of times that these 200 vessels were in the top 200 in previous and subsequent years is recorded by column. For example, of the top 200 gillnetters in 1977, 41 of those 200 were also in the top 200 in 1967 and 64 in the top 200 in 1981. Twenty-one or more vessels is indicative of a significant statistical association.

Year	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
1967	200	82	74	65	57	29	47	42	35	40	35	11	16	16	15
1968	82	200	85	67	72	39	43	37	34	32	29	13	16	17	18
1969	74	85	200	110	106	54	62	57	44	43	41	21	20	19	25
1970	65	67	110	200	102	65	57	54	45	43	34	21	16	19	26
1971	57	72	106	102	200	70	70	67	54	51	40	20	29	24	32
1972	29	39	54	65	70	200	54	58	48	44	39	30	32	25	28
1973	47	43	62	57	70	54	200	86	67	69	61	31	36	34	41
1974	42	37	57	54	67	58	86	200	94	79	69	38	35	33	42
1975	35	34	44	45	54	48	67	94	200	84	79	31	42	41	43
1976	40	32	43	43	51	44	69	79	84	200	93	42	46	44	52
1977	35	29	41	34	40	39	61	69	79	93	200	49	62	53	64
1978	11	13	21	21	20	30	31	38	31	42	49	200	65	53	44
1979	16	16	20	16	29	33	36	35	42	46	62	65	200	64	58
1980	16	17	19	19	24	25	34	33	41	44	53	53	64	200	74
1981	15	18	25	26	32	28	41	42	43	52	64	44	58	74	200

Table 6. Number of purse seiners accounting for varying percentages of the total seine landings of coho salmon in British Columbia, 1967-1981.

Percent of total landings	Year															
	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1967-81
10	9	8	6	7	9	7	8	9	10	10	12	12	16	9	12	10
20	18	20	13	16	20	17	18	21	22	23	25	34	35	24	29	22
30	29	36	22	28	33	32	29	34	35	41	42	61	58	45	50	38
40	41	57	33	41	47	52	42	49	50	64	60	93	84	72	76	57
50	55	82	47	60	64	79	57	66	67	93	81	131	116	110	109	81
60	73	113	67	90	88	112	78	89	86	132	106	173	155	157	150	111
70	102	150	100	132	124	153	113	127	110	182	142	224	202	215	204	152
80	157	194	149	189	176	204	169	184	161	246	198	283	262	287	276	209
90	243	252	225	269	246	268	21	273	250	328	291	359	346	382	372	291
100	510	482	417	561	542	533	474	496	499	492	490	496	516	532	532	505

Table 7. Frequencies (and percentage) of vessels landing coho salmon in British Columbia by purse seines 1967-1981.

Catch interval (pieces)	Year							
	1967	1968	1969	1970	1971	1972	1973	1974
0-500	328(64.3)	186(38.6)	332(79.6)	272(48.5)	237(43.7)	287(53.8)	194(40.9)	240(48.4)
501-1000	77(15.1)	117(24.3)	37(8.9)	144(25.7)	127(23.4)	143(26.8)	139(29.3)	116(23.4)
1001-1500	25(4.9)	87(18.0)	20(4.8)	55(9.8)	57(10.5)	55(10.3)	45(9.5)	41(8.3)
1501-2000	10(2.0)	36(7.5)	10(2.4)	25(4.5)	35(6.5)	16(3.0)	15(3.2)	17(3.4)
2001-2500	16(3.1)	24(5.0)	10(2.4)	14(2.5)	11(2.0)	10(1.9)	10(2.1)	10(2.0)
2501-3000	13(2.5)	7(1.5)	7(1.7)	2(0.4)	9(1.7)	6(1.1)	10(2.1)	14(2.8)
3001-3500	10(2.0)	6(1.2)	1(0.2)	6(1.1)	10(1.8)	9(1.7)	10(2.1)	13(2.6)
3501-4000	14(2.7)	6(1.2)	0(0.0)	9(1.6)	6(1.1)	1(0.2)	11(2.3)	19(3.8)
4001-4500	12(2.4)	3(0.6)	0(0.0)	9(1.6)	15(2.8)	3(0.6)	8(1.7)	11(2.2)
4501-5000	2(0.4)	4(0.8)	0(0.0)	8(1.4)	11(2.0)	2(0.4)	2(0.4)	5(2.0)
5000+	3(0.6)	6(1.2)	0(0.0)	17(3.0)	24(4.4)	1(0.2)	30(6.3)	10(1.0)
Total	510	482	417	561	542	533	474	496

Catch interval (pieces)	Year							
	1975	1976	1977	1978	1979	1980	1981	1967-81
0-500	276(55.3)	176(35.8)	176(35.9)	172(34.7)	174(33.7)	242(45.5)	176(33.1)	231(45.7)
501-1000	95(19.0)	184(37.4)	118(24.1)	206(41.5)	156(30.2)	183(34.4)	176(33.1)	135(26.7)
1001-1500	16(3.2)	52(10.6)	52(10.6)	78(15.7)	77(14.9)	51(9.6)	74(13.9)	52(10.3)
1501-2000	13(2.6)	27(5.5)	27(5.5)	30(6.0)	53(10.3)	23(4.3)	39(7.3)	25(5.0)
2001-2500	18(3.6)	21(4.3)	19(3.9)	5(1.0)	26(5.0)	12(2.3)	23(4.3)	15(3.0)
2501-3000	26(5.2)	12(2.4)	12(2.4)	2(0.4)	19(3.7)	10(1.9)	26(4.9)	12(2.4)
3001-3500	14(2.8)	7(1.4)	25(5.1)	1(0.2)	7(1.4)	2(0.4)	9(1.7)	9(1.8)
3501-4000	17(3.4)	3(0.6)	24(4.9)	0(0.0)	2(0.4)	2(0.4)	5(0.9)	8(1.6)
4001-4500	12(2.4)	5(1.0)	11(2.2)	0(0.0)	2(0.4)	2(0.4)	1(0.2)	6(1.2)
4501-5000	8(1.6)	2(0.4)	11(2.2)	0(0.0)	0(0.0)	2(0.4)	0(0.0)	4(0.8)
5000+	4(0.8)	3(0.6)	15(3.1)	2(0.4)	0(0.0)	3(0.6)	3(0.6)	8(1.6)
Total	499	492	490	496	516	532	532	505

Table 8. A measure of the repeatability of success of landing coho salmon by purse seiners. The top 100 seiners in terms of number of coho salmon landed were identified each year (diagonal in table). The number of times that those 100 vessels were in the top 100 in previous and subsequent years is recorded by column. For example, of the top 100 seiners in 1975, 45 of those 100 were also in the top 100 in 1969 and 41 in vessels in 1981. Twenty-nine or more vessels is indicative of a significant statistical association.

Year	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
1969	100	42	60	49	44	40	40	31	37	19	22	19	28
1970	42	100	43	34	30	24	25	19	22	14	16	14	17
1971	60	43	100	54	58	48	45	35	45	19	25	23	32
1972	49	34	54	100	46	37	34	24	26	14	18	13	17
1973	44	30	58	46	100	65	60	46	50	24	34	29	33
1974	40	24	48	37	65	100	72	55	57	29	36	30	34
1975	40	25	45	34	60	72	100	57	67	28	41	34	40
1976	31	19	35	24	46	55	57	100	53	31	36	39	38
1977	37	22	45	26	50	57	67	53	100	33	51	39	54
1978	19	14	19	14	24	29	28	31	33	100	40	33	32
1979	22	16	25	18	34	36	41	36	51	40	100	49	56
1980	19	14	23	13	29	30	34	39	39	33	49	100	50
1981	28	17	32	17	33	34	40	38	54	32	56	50	100

Table 9. Number of trollers accounting for varying percentages of the total troll landings of coho salmon in British Columbia, 1967-1981.

Percent of total landings	Year															
	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1967-81
10	54	28	42	42	48	52	43	41	38	38	56	57	57	58	51	47
20	131	64	107	102	119	125	103	99	89	93	130	140	140	135	121	113
30	228	104	188	182	211	216	179	172	157	158	219	240	241	230	206	195
40	343	154	288	282	325	325	275	260	242	239	327	361	359	348	307	296
50	477	214	407	408	461	455	392	368	347	338	456	500	497	496	427	416
60	637	291	551	569	625	610	536	499	480	459	610	665	662	675	572	563
70	835	398	727	777	825	800	712	660	650	614	794	866	860	899	756	745
80	1084	556	963	1062	1083	1047	937	865	874	820	1031	1118	1120	1185	997	983
90	1445	851	1321	1492	1446	1399	1250	1170	1189	1144	1391	1484	1487	1595	1344	1334
100	3374	2688	3007	3349	3319	3098	2642	2531	2540	2603	2708	2854	2878	3228	2760	2905

Table 10. Frequencies (and percentage) of vessels landing coho salmon in British Columbia by troll gear, 1967-1981.

Catch interval (pieces)	Year							
	1967	1968	1969	1970	1971	1972	1973	1974
0-500	2091(62.0)	2020(75.1)	1886(62.7)	1967(58.7)	1632(49.2)	1678(54.2)	1265(47.9)	1200(47.4)
501-1000	595(17.6)	245(9.1)	492(16.4)	610(18.2)	472(14.2)	537(17.3)	486(18.4)	398(15.7)
1001-1500	337(10.0)	128(4.8)	293(9.7)	286(8.5)	371(11.2)	350(11.3)	328(12.4)	276(10.9)
1501-2000	189(5.6)	87(3.2)	162(5.4)	172(5.1)	252(7.6)	220(7.1)	211(8.0)	206(8.1)
2001-2500	80(2.4)	54(2.0)	79(2.6)	96(2.9)	191(5.8)	133(4.3)	115(4.4)	140(5.5)
2501-3000	42(1.2)	53(2.0)	43(1.4)	73(2.2)	121(3.6)	75(2.4)	76(2.9)	88(3.5)
3001-3500	23(0.7)	19(0.7)	20(0.7)	44(1.3)	91(2.7)	42(1.4)	51(1.9)	70(2.8)
3501-4000	8(0.2)	51(2.0)	16(0.5)	30(0.9)	54(1.6)	30(1.0)	38(1.4)	49(1.9)
4001-4500	4(0.1)	16(0.6)	4(0.1)	23(0.7)	35(1.1)	16(0.5)	23(0.9)	31(1.2)
4500+	5(0.1)	15(0.6)	12(0.4)	48(1.4)	100(3.0)	17(0.5)	49(1.9)	73(2.9)
Total	3374	2688	3007	3349	3319	3098	2642	2531

Catch interval (pieces)	Year							
	1975	1976	1977	1978	1979	1980	1981	1967-81
0-500	1598(62.9)	1320(50.7)	1350(49.9)	1286(45.1)	1254(43.6)	1604(49.7)	1445(52.4)	1574(58.2)
501-1000	500(19.7(	373(14.3)	491(18.1)	568(19.9)	546(19.0)	642(19.9)	553(20.0)	499(17.2)
1001-1500	212(8.3)	247(9.5)	365(13.5)	388(13.6)	344(12.0)	386(12.0)	284(10.3)	306(10.5)
1501-2000	103(4.1)	170(6.5)	212(7.8)	271(9.5)	267(9.3)	231(7.2)	188(6.8)	196(6.7)
2001-2500	46(1.8)	131(5.0)	112(4.1)	134(4.7)	192(6.7)	114(3.5)	133(4.8)	117(4.0)
2501-3000	39(1.5)	92(3.5)	85(3.1)	97(3.4)	105(3.6)	89(2.8)	72(2.6)	77(2.7)
3001-3500	23(0.9)	73(2.8)	58(2.1)	60(2.1)	75(2.6)	62(1.9)	40(1.4)	50(1.7)
3501-4000	8(0.3)	41(1.6)	19(0.7)	23(0.8)	40(1.4)	42(1.3)	17(0.6)	31(1.1)
4001-4500	5(0.2)	47(1.8)	8(0.3)	10(0.4)	21(0.7)	30(0.9)	16(0.6)	19(0.7)
4500+	6(0.2)	109(4.2)	8(0.3)	17(0.6)	34(1.2)	28(0.9)	12(0.4)	36(1.2)
Total	2540	2603	2708	2854	2878	3228	2760	2905

Table 11. A measure of the repeatability of success of landing coho salmon by trollers. The top 200 trollers in terms of number of coho salmon landed were identified each year (diagonal in table). The number of times that those 200 vessels were in the top 200 in previous and subsequent years is recorded by column. For example, of the top 200 trollers in 1975, 53 of those 200 were also in the top 200 trollers in 1967 and 61 in the top 200 in 1981. Twenty-one or more vessels is indicative of a significant statistical association.

Year	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
1967	200	17	83	78	71	56	62	55	53	54	51	48	45	32	35
1968	17	200	20	18	18	19	27	12	11	12	15	17	13	13	10
1969	83	20	200	119	94	84	75	75	68	58	57	47	43	40	40
1970	78	18	119	200	108	81	94	79	74	69	61	51	48	43	44
1971	71	18	94	108	200	75	80	81	72	69	64	54	50	40	45
1972	56	19	84	81	75	200	96	75	76	63	52	67	52	50	46
1973	62	27	75	94	80	96	200	109	90	89	81	76	62	64	51
1974	55	12	75	79	81	75	109	200	114	100	97	69	66	64	58
1975	53	11	68	74	72	76	90	114	200	107	97	62	71	64	61
1976	54	12	58	69	69	63	89	100	107	200	106	79	71	71	59
1977	51	15	57	61	64	52	81	97	97	106	200	83	85	72	72
1978	48	17	47	51	54	67	76	69	62	79	83	200	88	78	66
1979	45	13	43	48	50	52	62	66	71	71	85	88	200	106	89
1980	32	13	40	43	40	50	64	64	64	71	72	78	106	200	105
1981	35	10	40	44	45	46	51	58	61	59	72	66	89	105	200

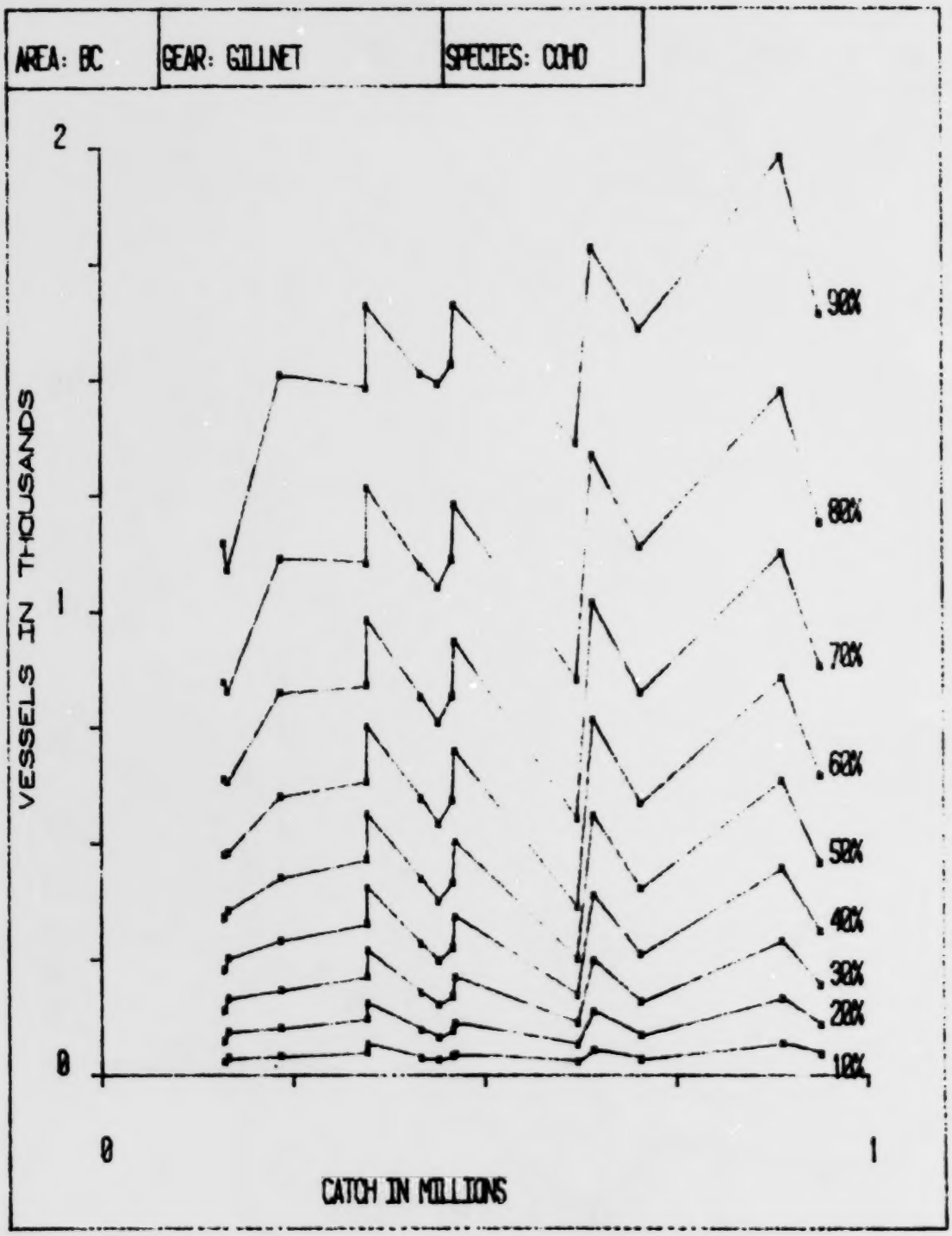


Figure 1. Contour plots for the number of gillnetters that harvested a fixed percentage of the total annual catch of coho salmon by gillnetters versus the size of the annual catch during 1967-1981.

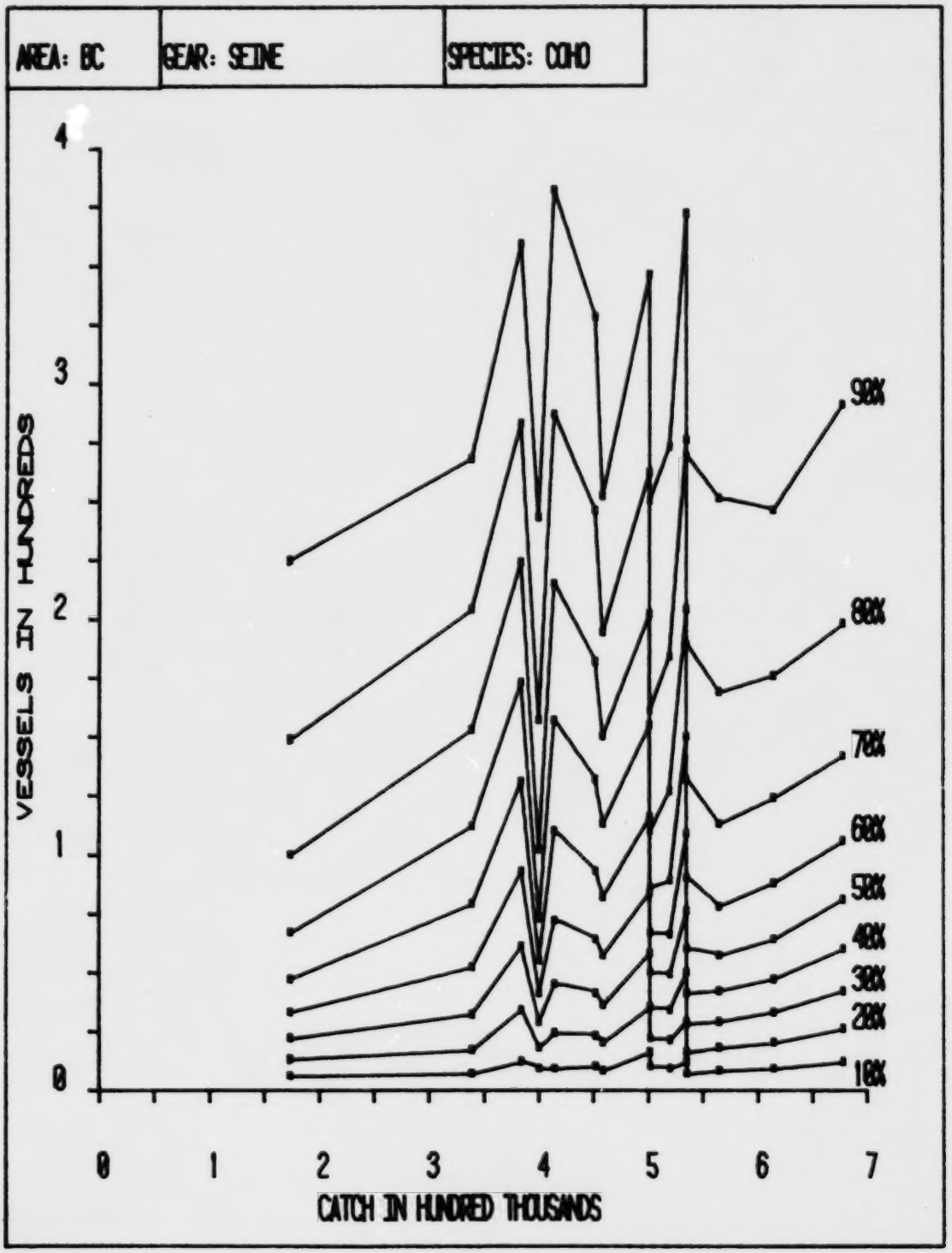


Figure 2. Contour plots for the number of seiners that harvested a fixed percentage of the total annual catch of coho salmon by seiners versus the size of the annual catch during 1967-1981.

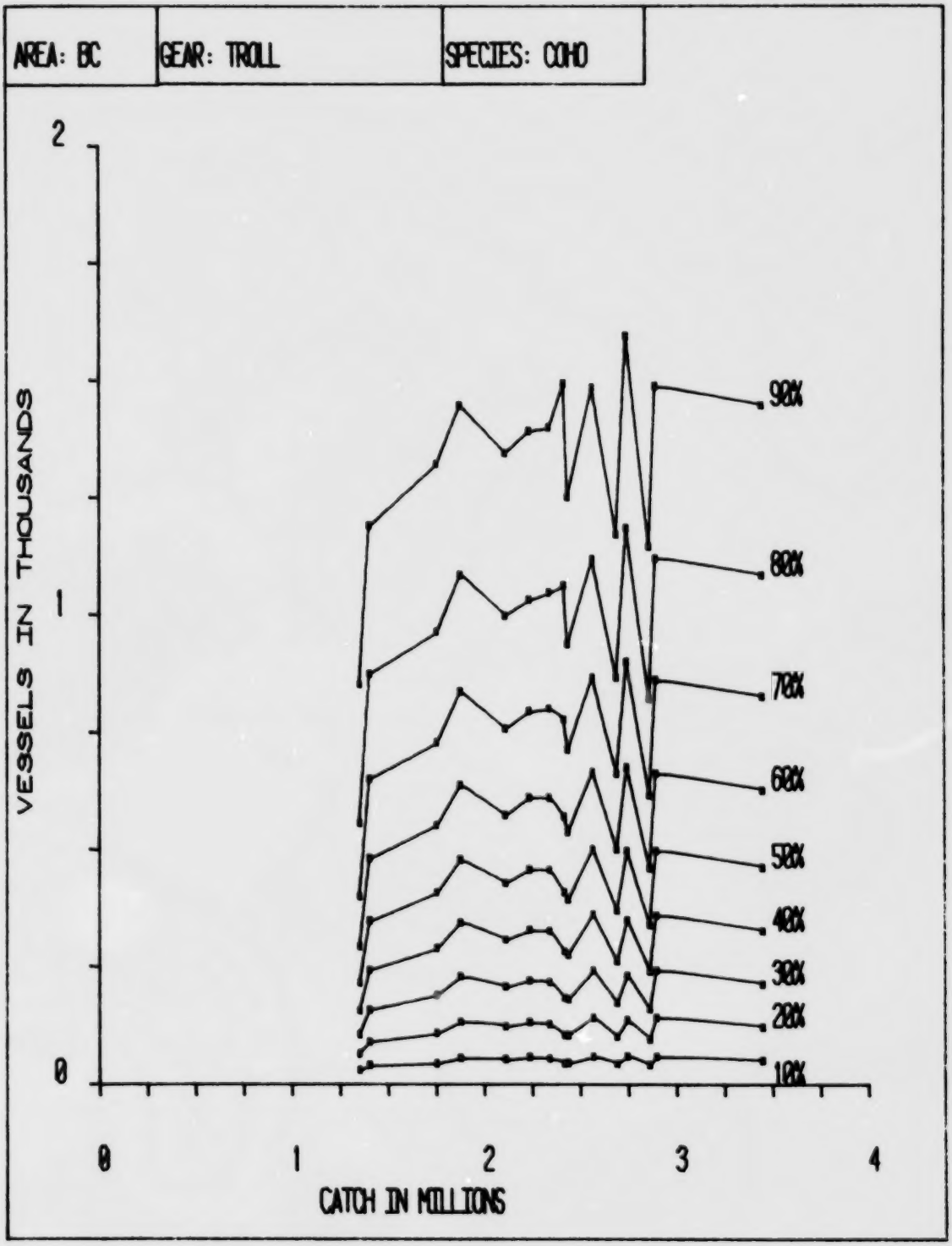


Figure 3. Contour plots for the number of trollers that harvested a fixed percentage of the total annual catch of coho salmon by trollers versus the size of the annual catch during 1967-1981.

APPENDIX A

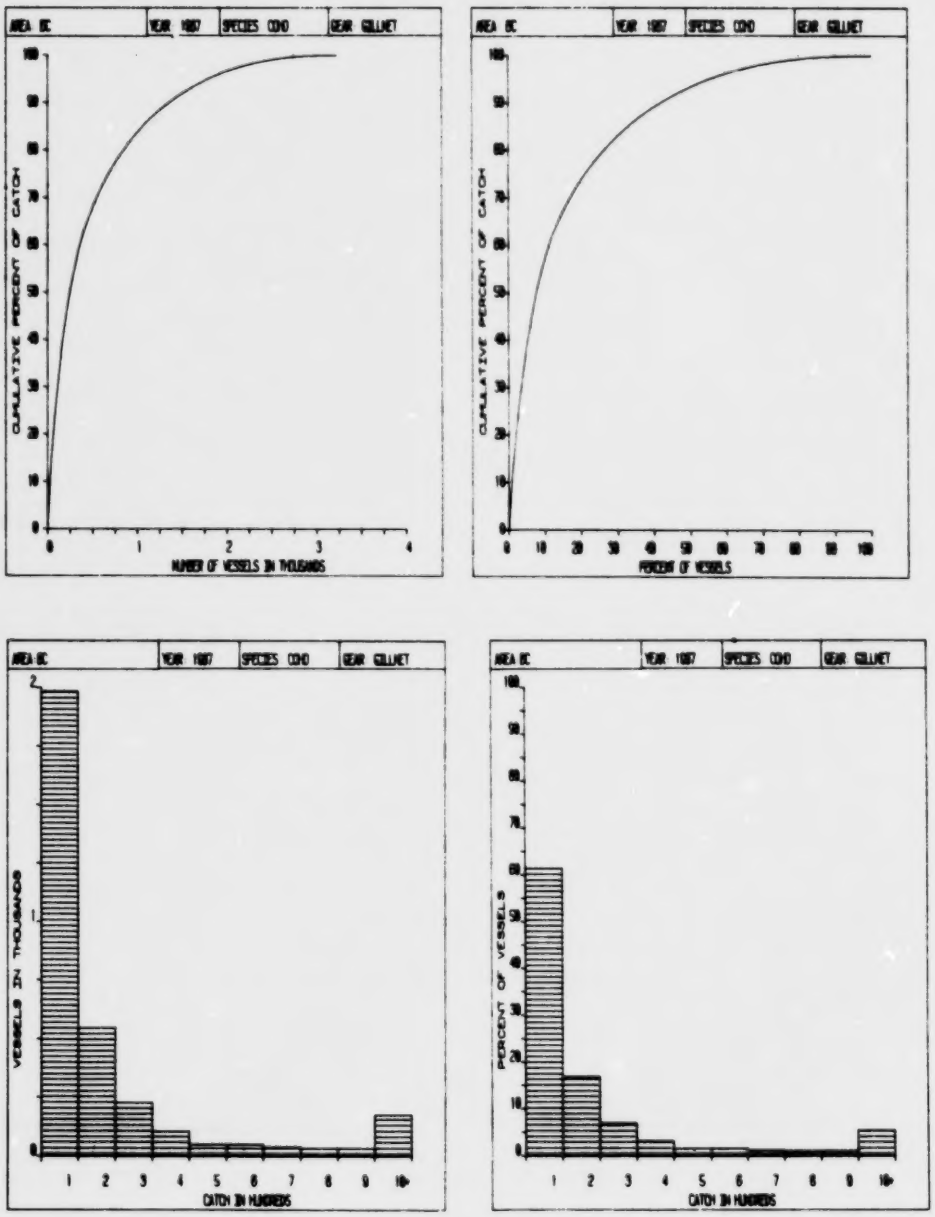


Figure A1. Cumulative percent and frequency of catch of coho salmon versus number and percent of vessels that used gillnets and participated in the fishery, 1967.

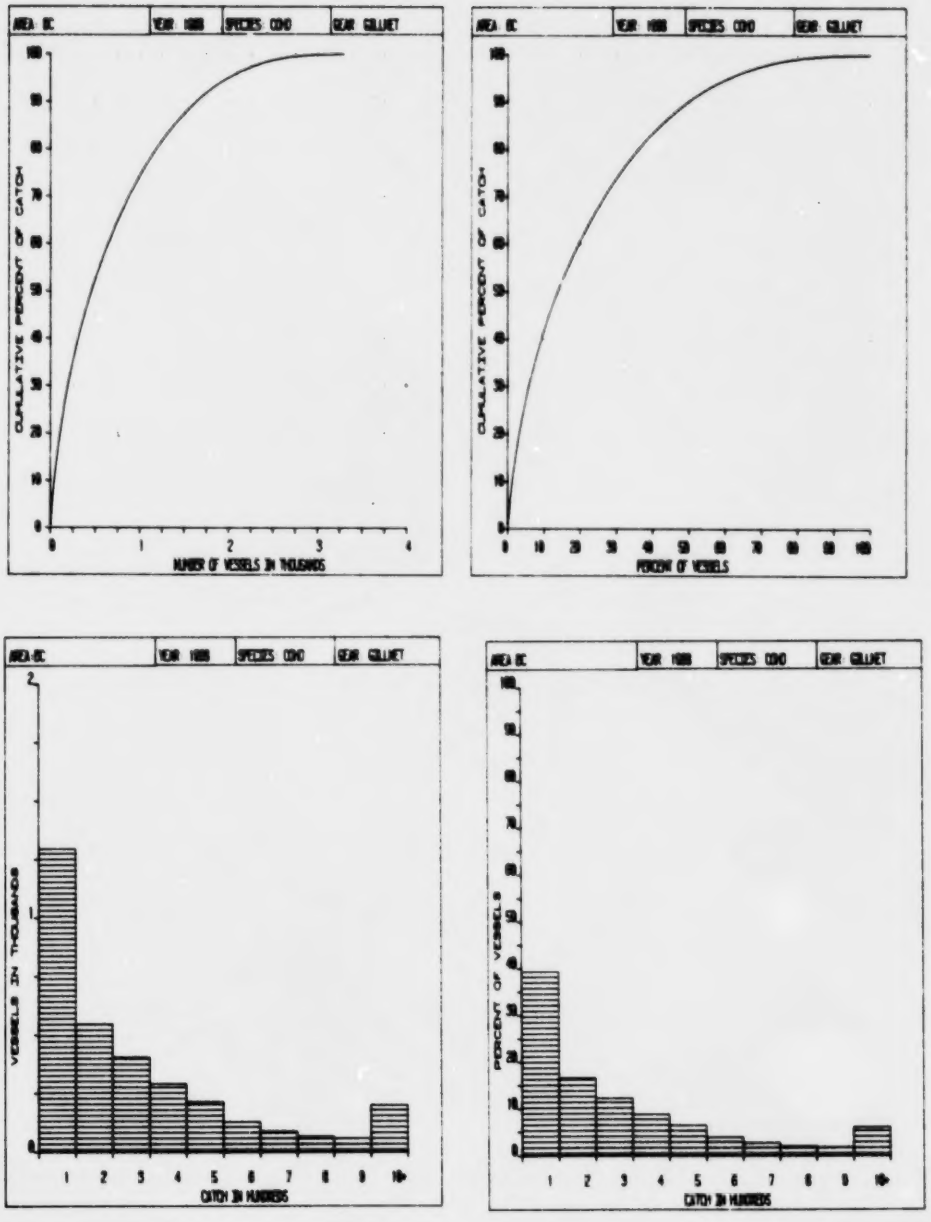


Figure A2. Cululative percent and frequency of catch of coho salmon versus number and percent of vessels that used gillnets and participated in the fishery, 1968.

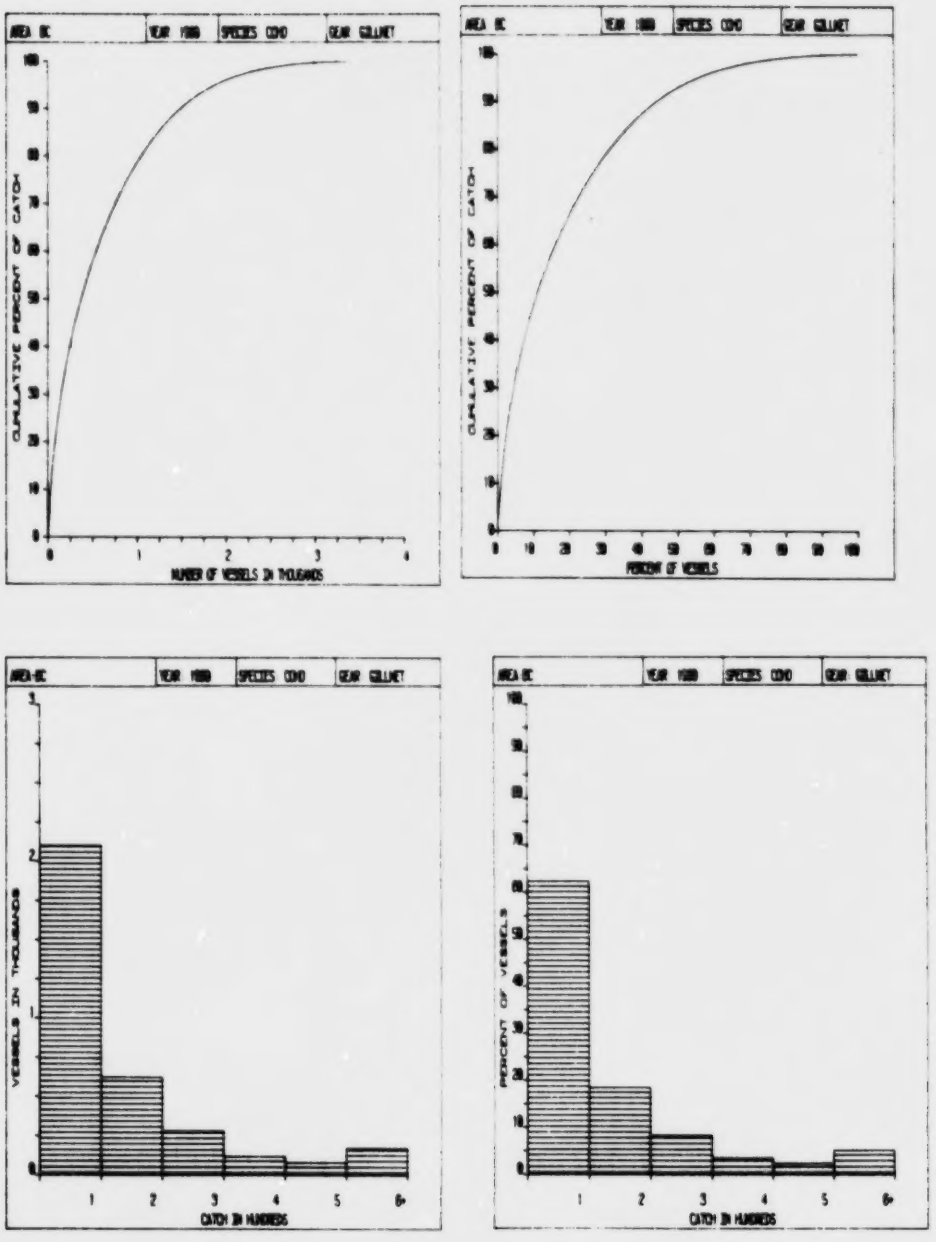


Figure A3. Cumulative percent and frequency of catch of coho salmon versus number and percent of vessels that used gillnets and participated in the fishery, 1969.

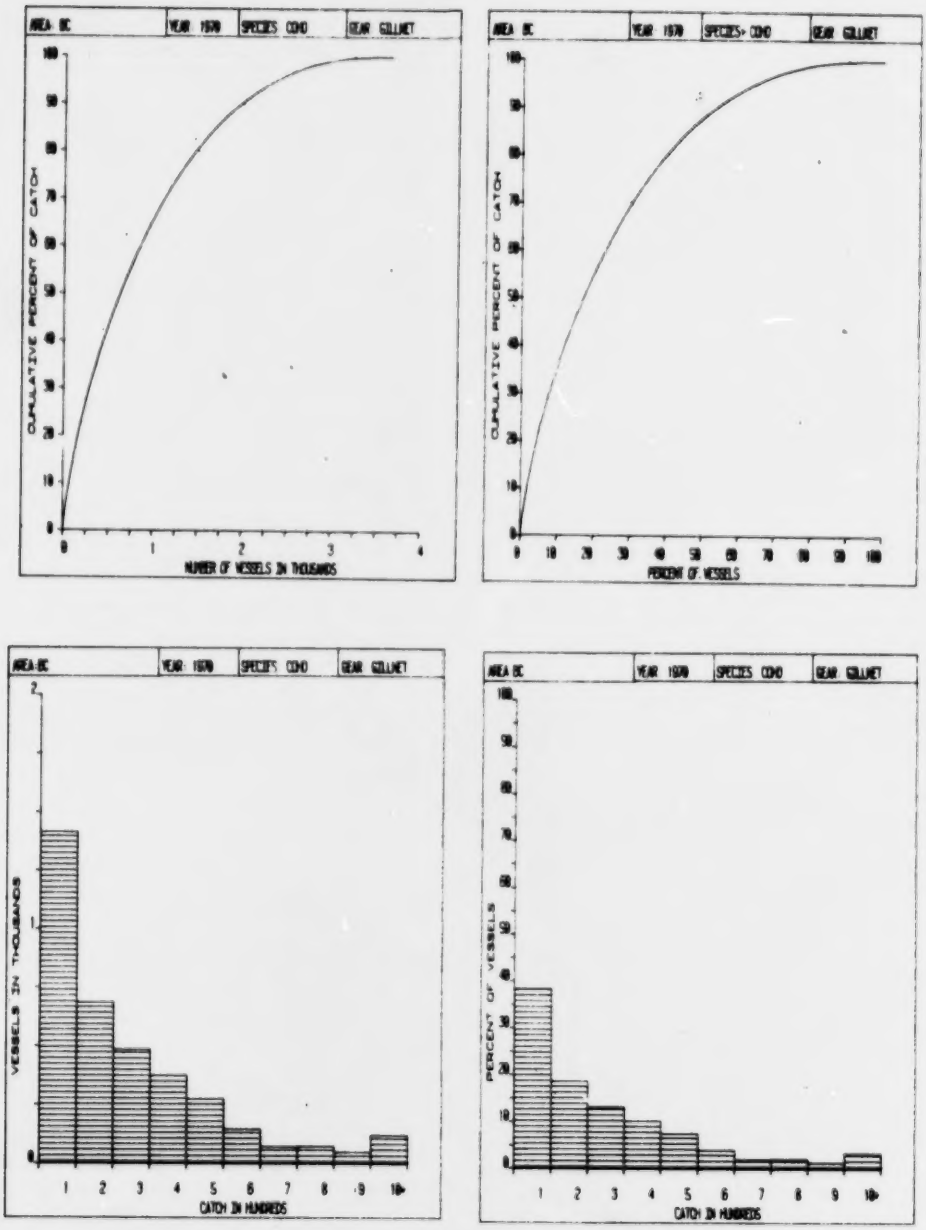


Figure A4. Cumulative percent and frequency of catch of coho salmon versus number and percent of vessels that used gillnets and participated in the fishery, 1970.

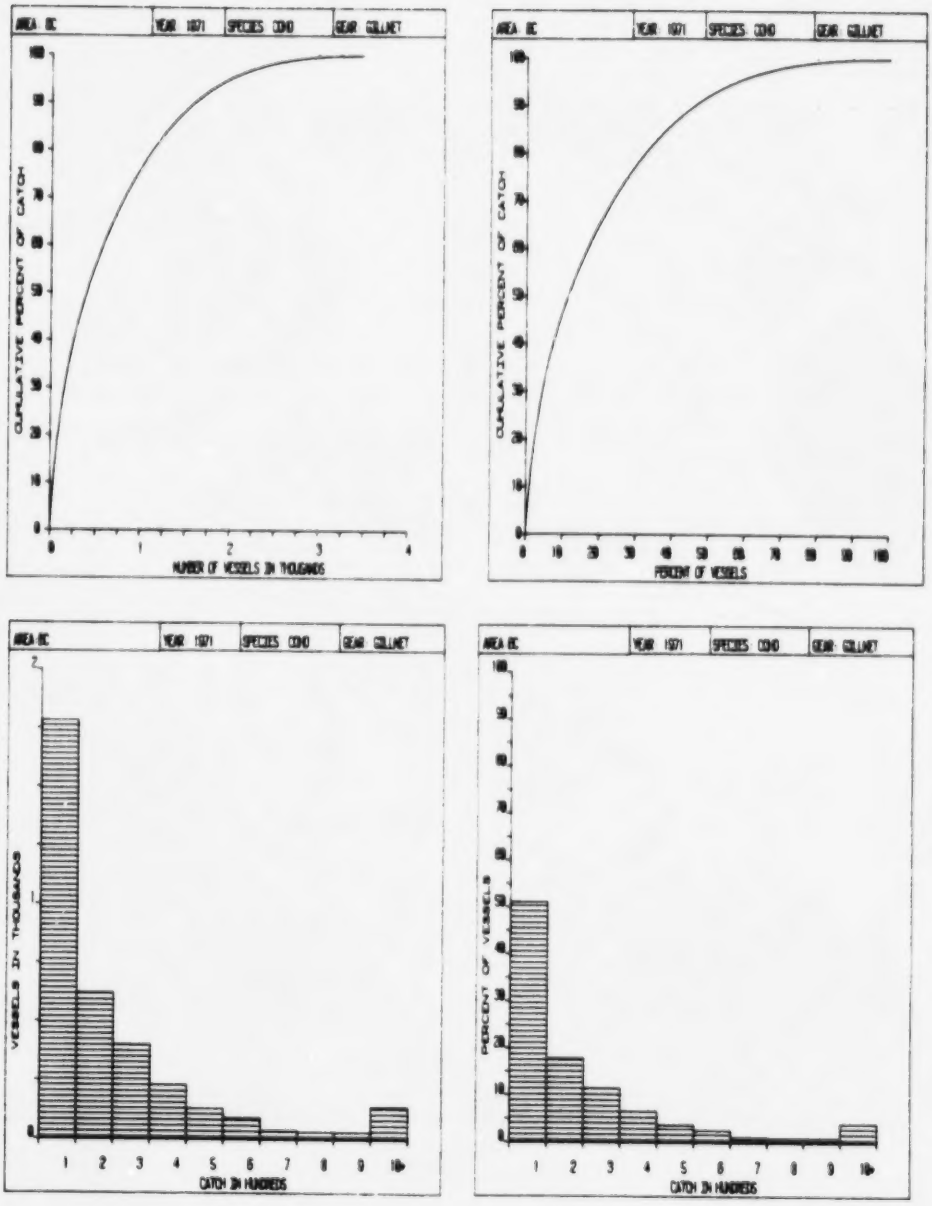


Figure A5. Cumulative percent and frequency of catch of coho salmon versus number and percent of vessels that used gillnets and participated in the fishery, 1971.

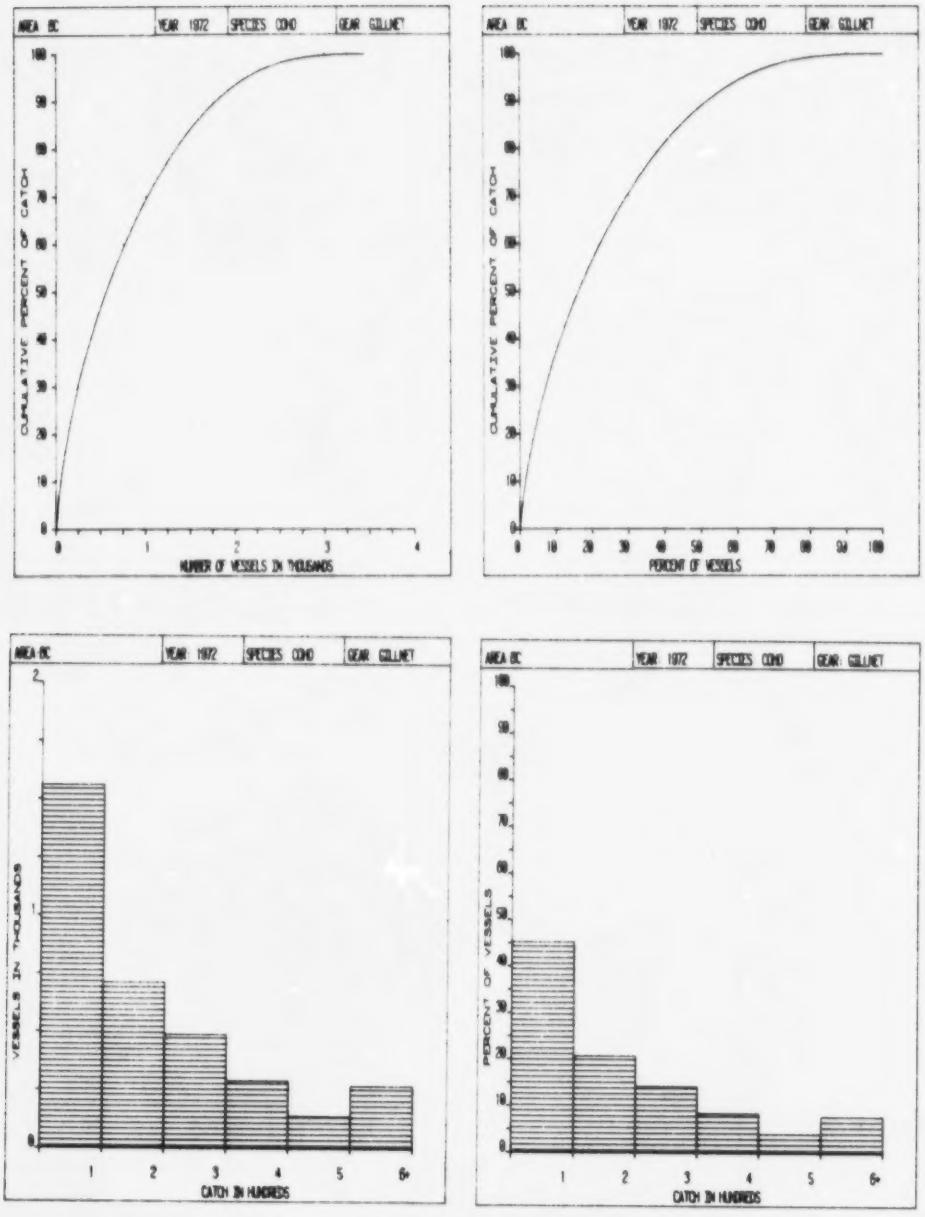


Figure A6. Cumulative percent and frequency of catch of coho salmon versus number and percent of vessels that used gillnets and participated in the fishery, 1972.

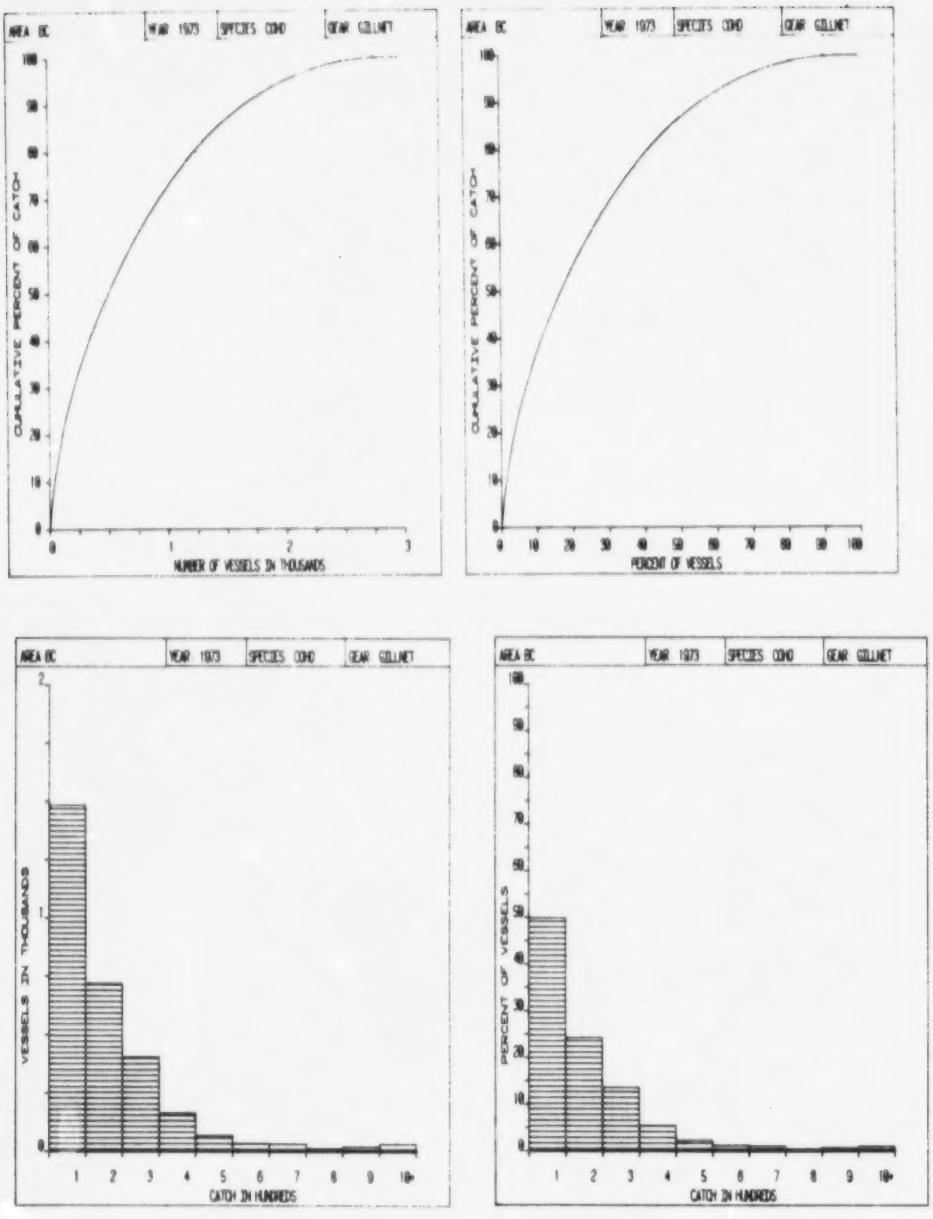


Figure A7. Cumulative percent and frequency of catch of coho salmon versus number and percent of vessels that used gillnets and participated in the fishery, 1973.

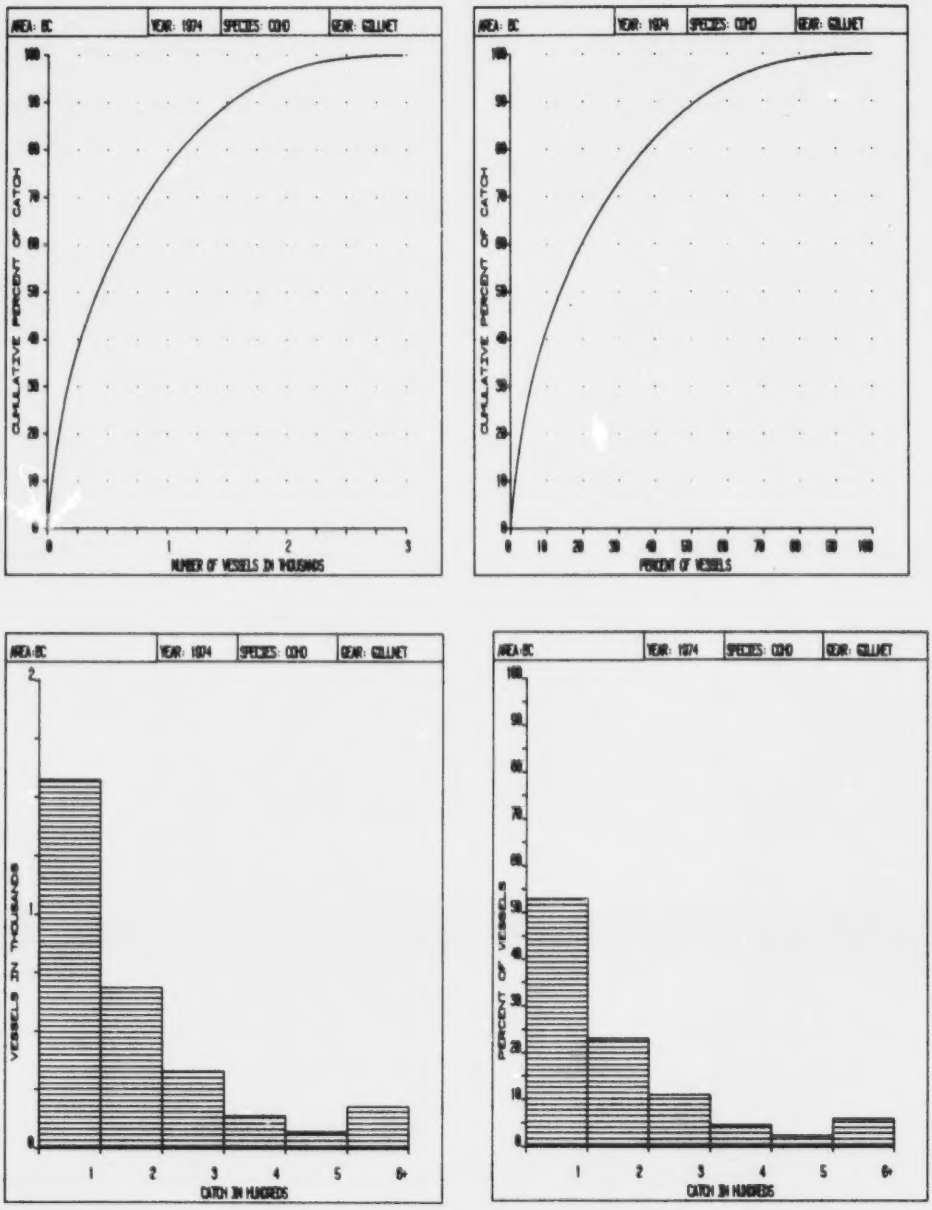


Figure A8. Cumulative percent and frequency of catch of coho salmon versus number and percent of vessels that used gillnets and participated in the fishery, 1974.

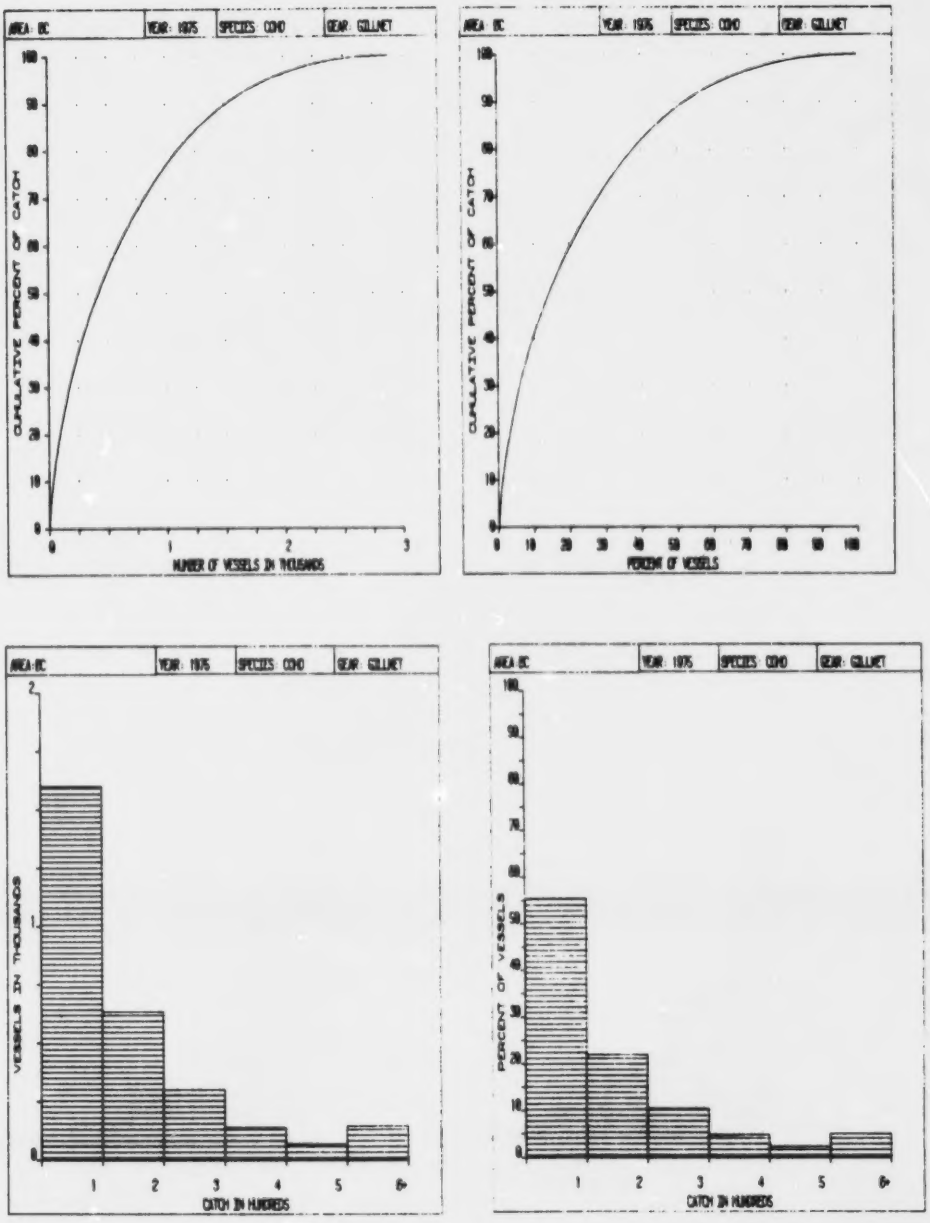


Figure A9. Cumulative percent and frequency of catch of coho salmon versus number and percent of vessels that used gillnets and participated in the fishery, 1975.

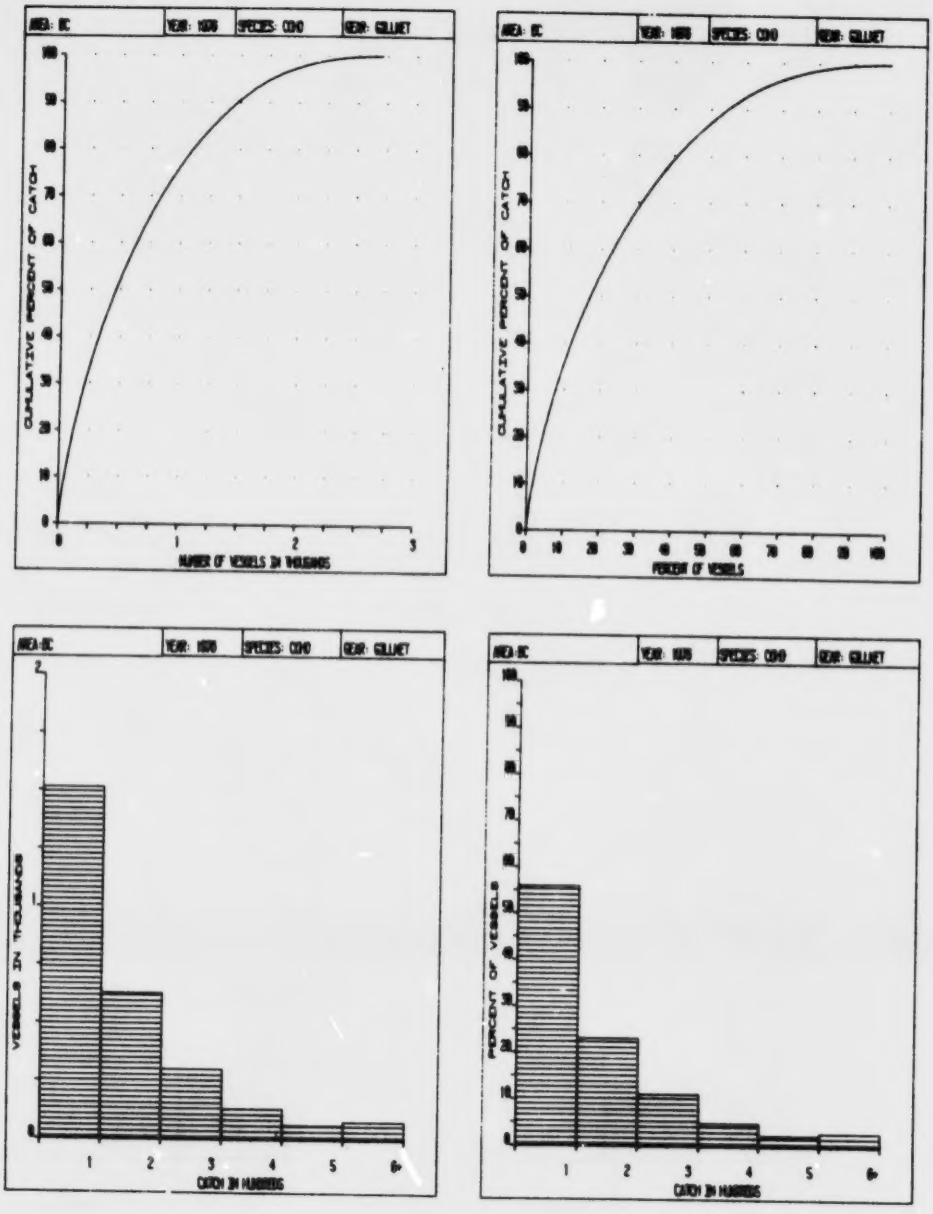


Figure 10. Cumulative percent and frequency of catch of coho salmon versus number and percent of vessels that used gillnets and participated in the fishery, 1976.

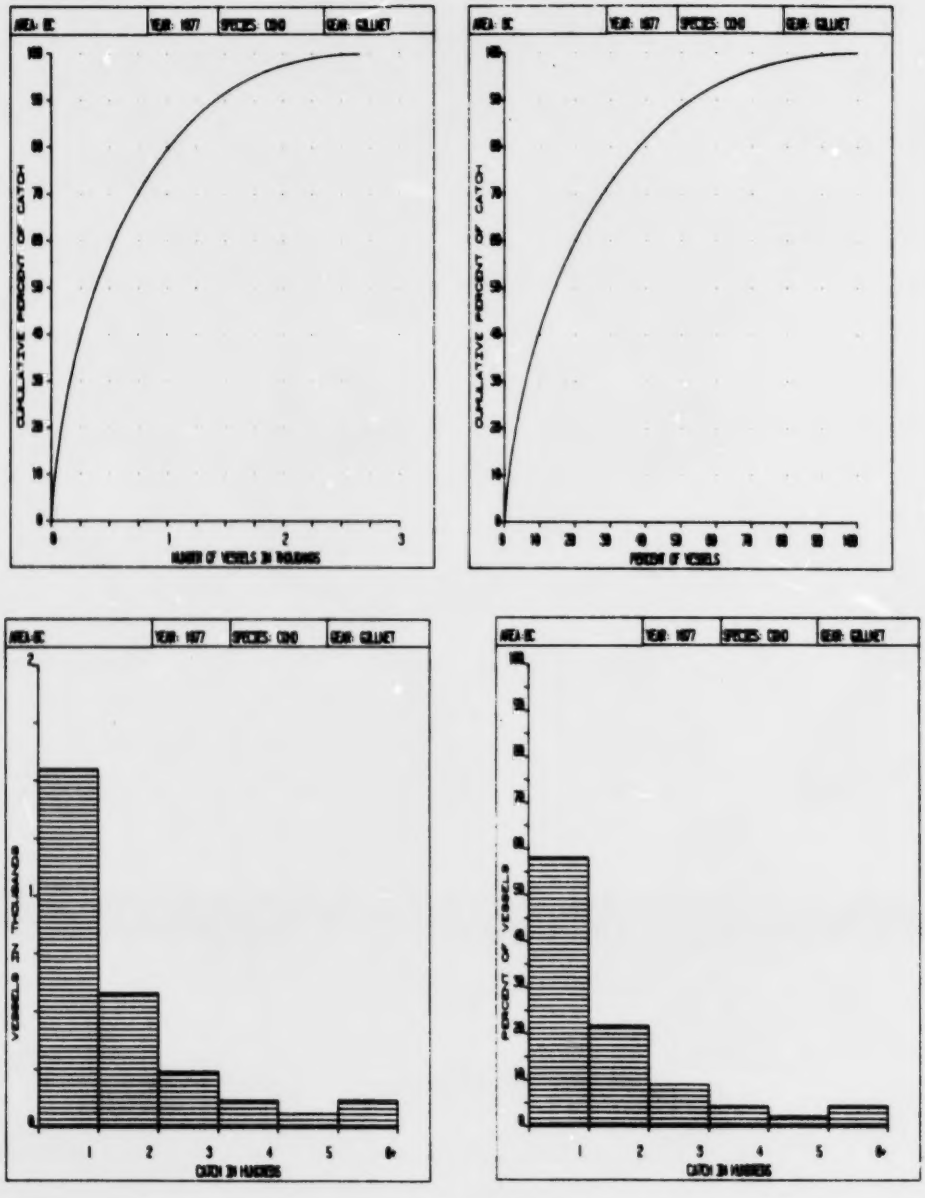


Figure A11. Cumulative percent and frequency of catch of coho salmon versus number and percent of vessels that used gillnets and participated in the fishery, 1977.

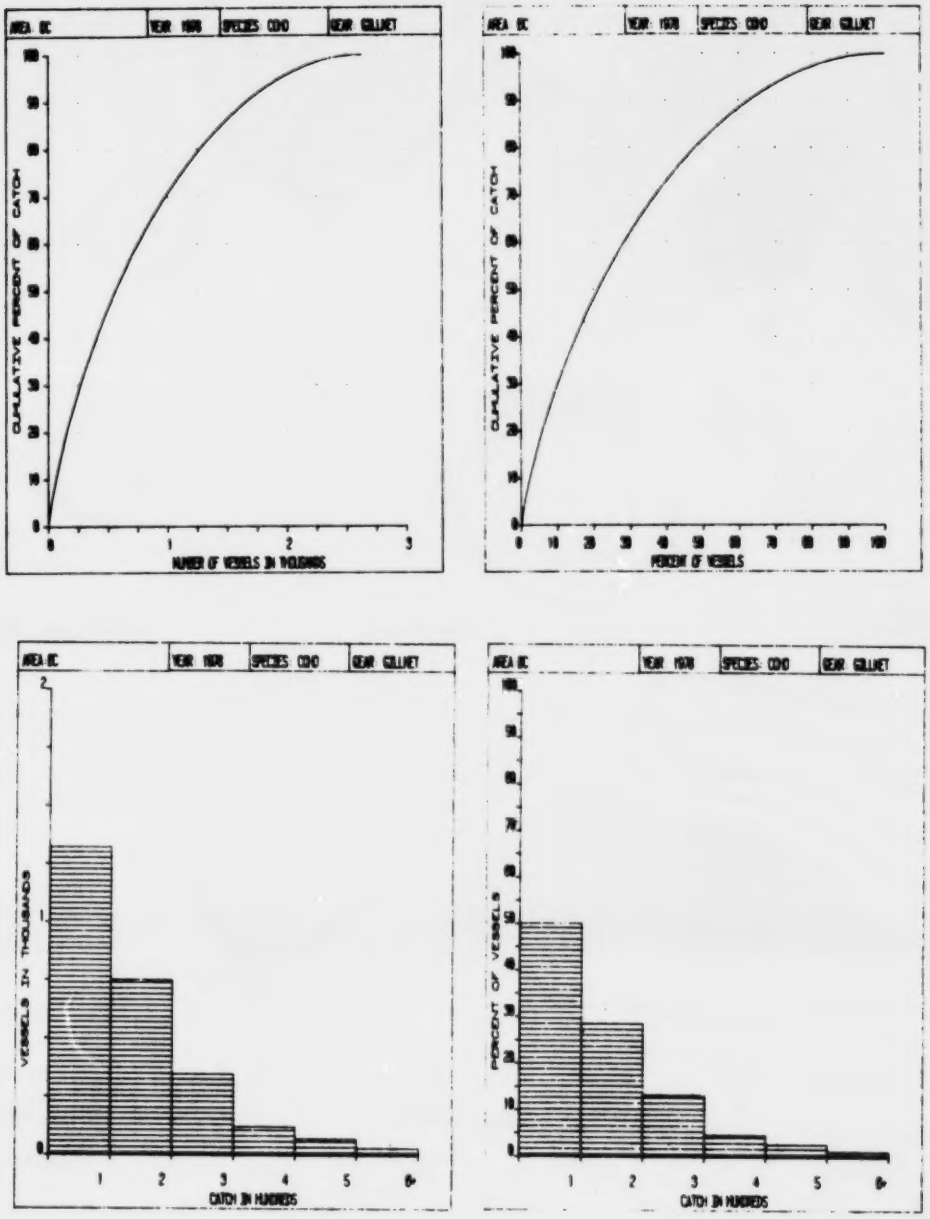


Figure A12. Cumulative percent and frequency of catch of coho salmon versus number and percent of vessels that used gillnets and participated in the fishery, 1978.

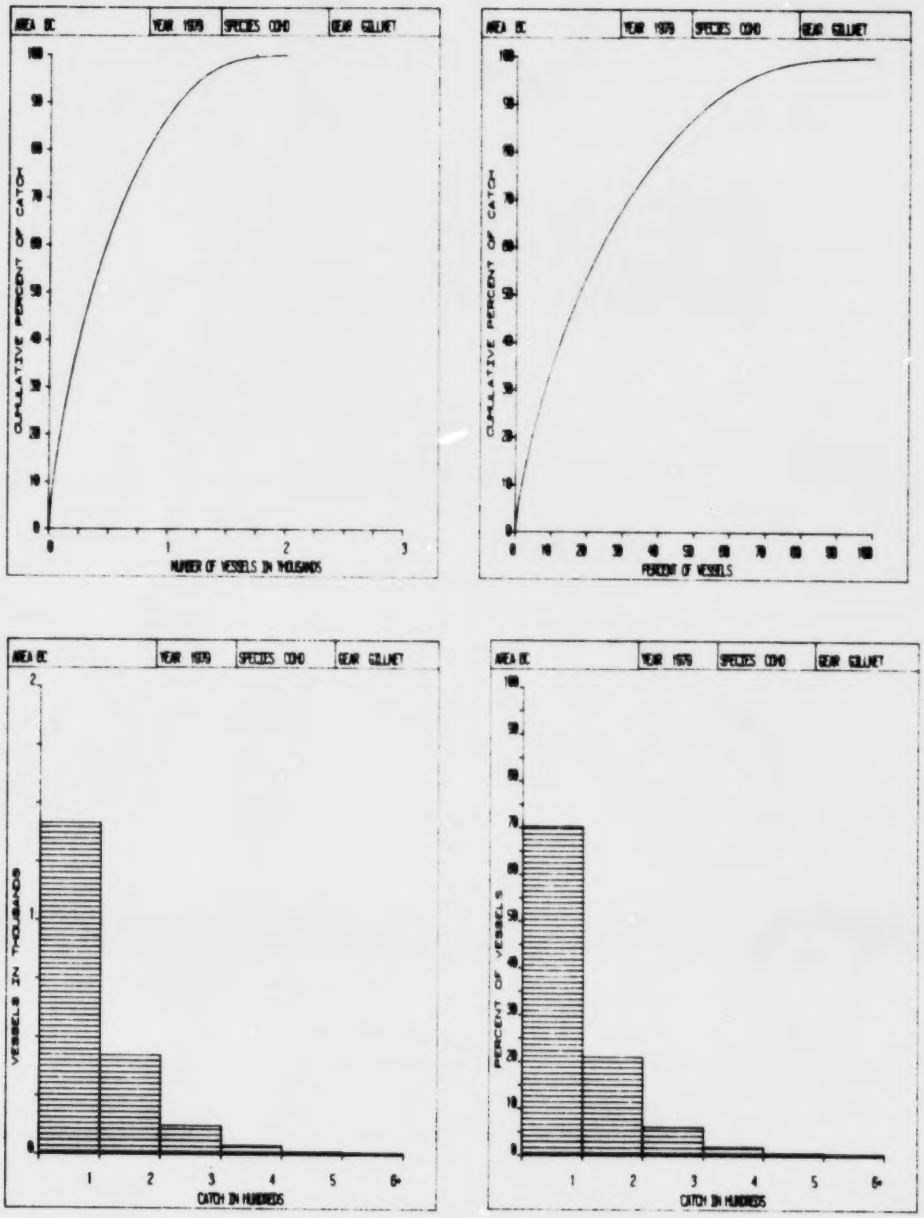


Figure A13. Cumulative percent and frequency of catch of coho salmon versus number and percent of vessels that used gillnets and participated in the fishery, 1979.

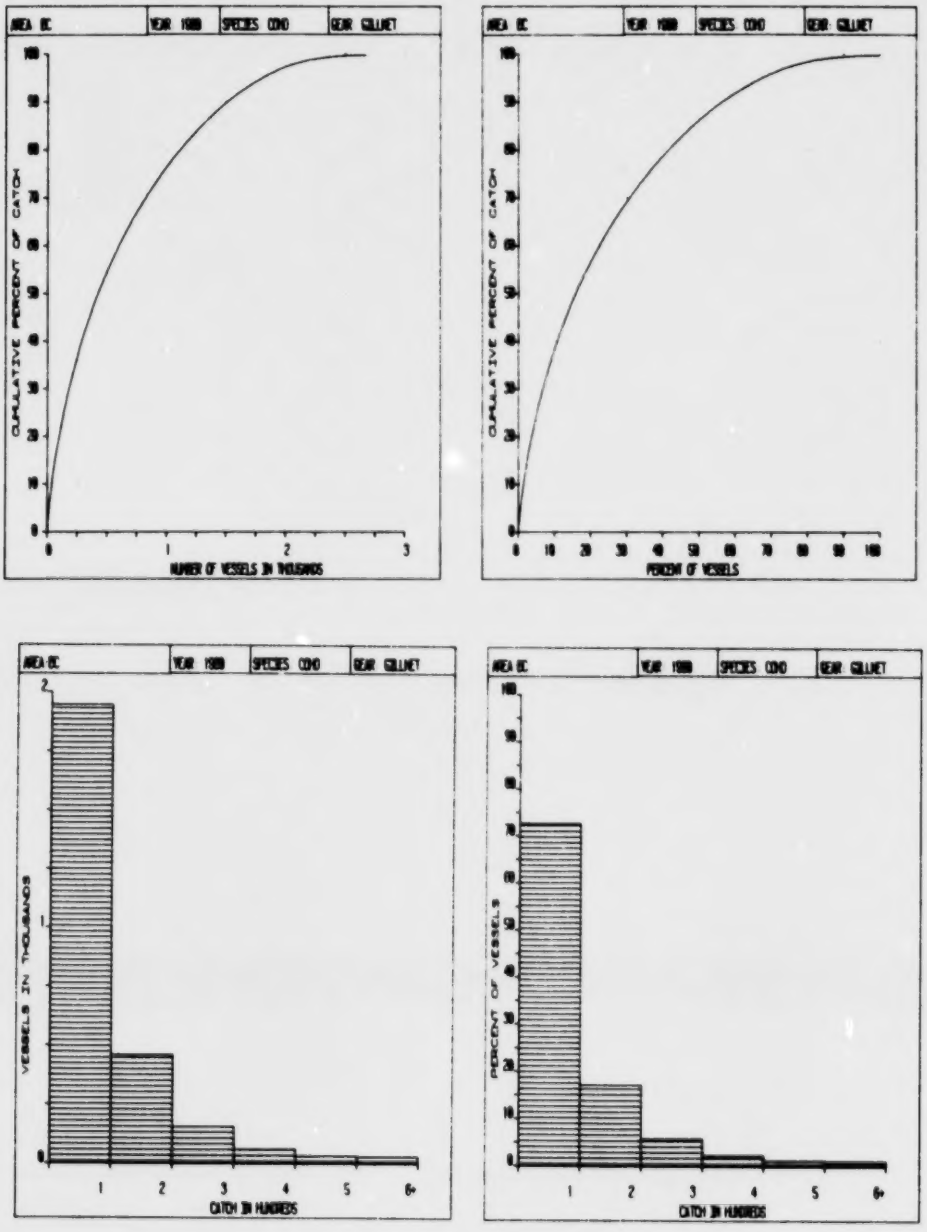


Figure A14. Cumulative percent and frequency of catch of coho salmon versus number and percent of vessels that used gillnets and participated in the fishery, 1980.

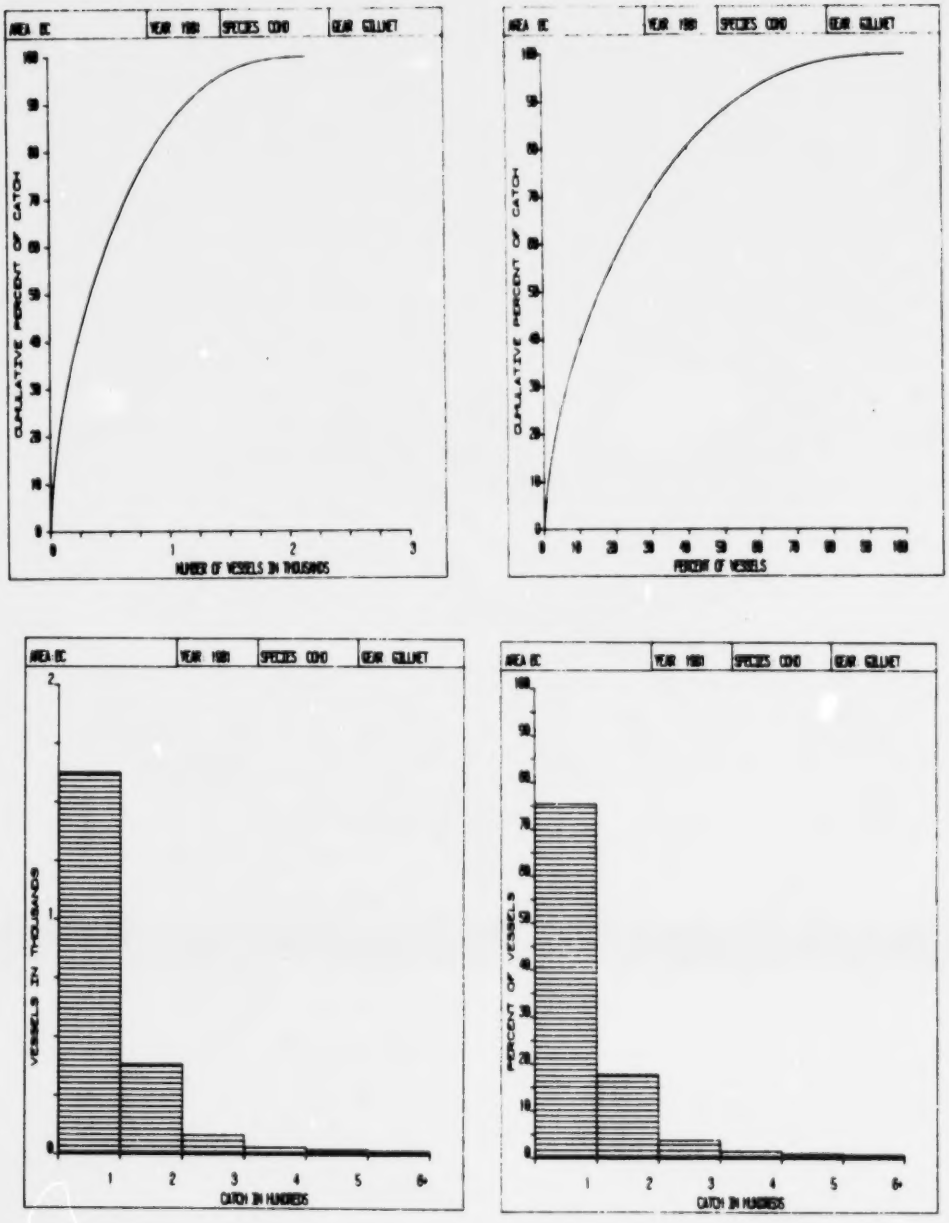


Figure A15. Cumulative percent and frequency of catch of coho salmon versus number and percent of vessels that used gillnets and participated in the fishery, 1981.

APPENDIX B

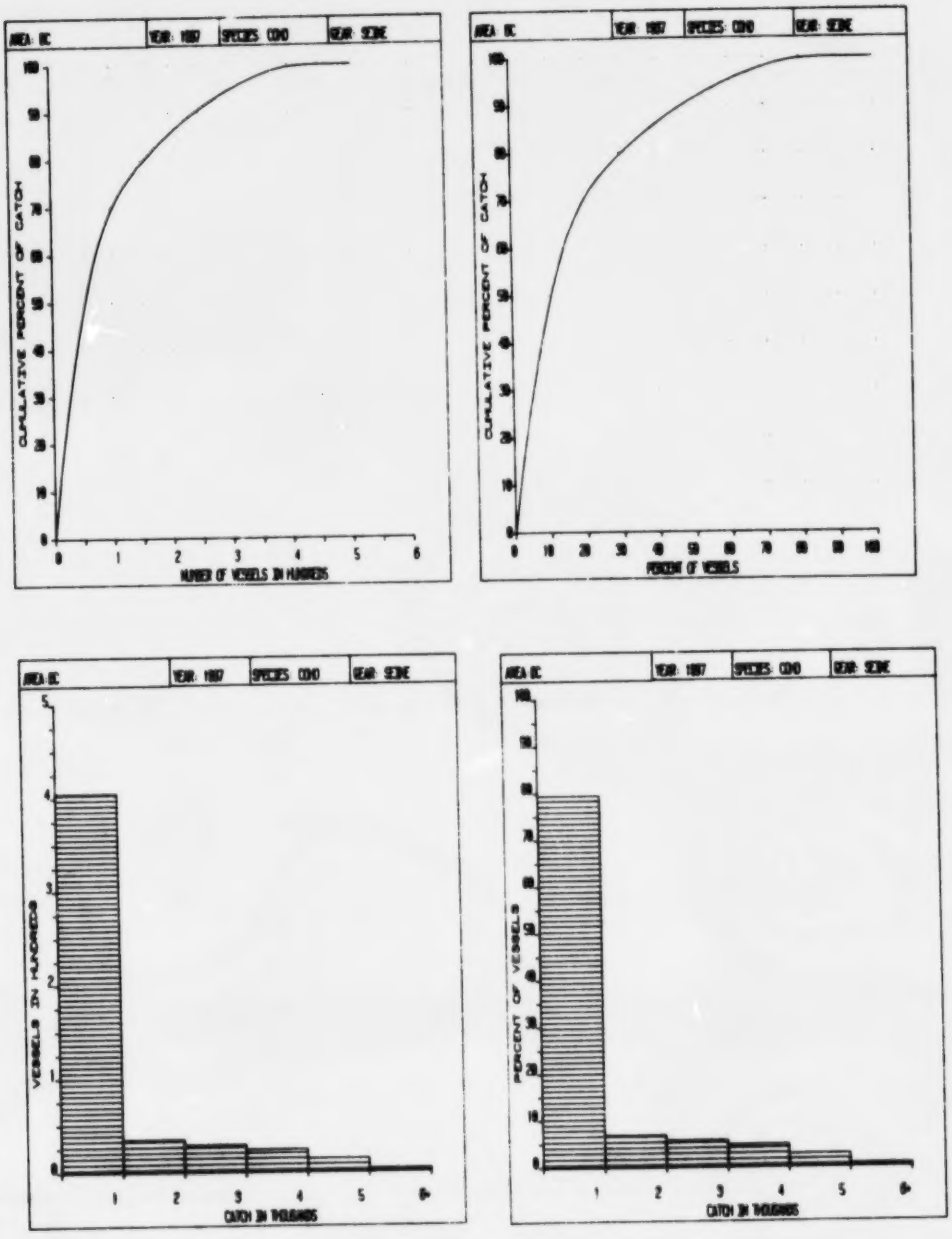


Figure B1. Cumulative percent and frequency of catch of coho salmon versus number and percent of purse seiners that participated in the fishery, 1967.

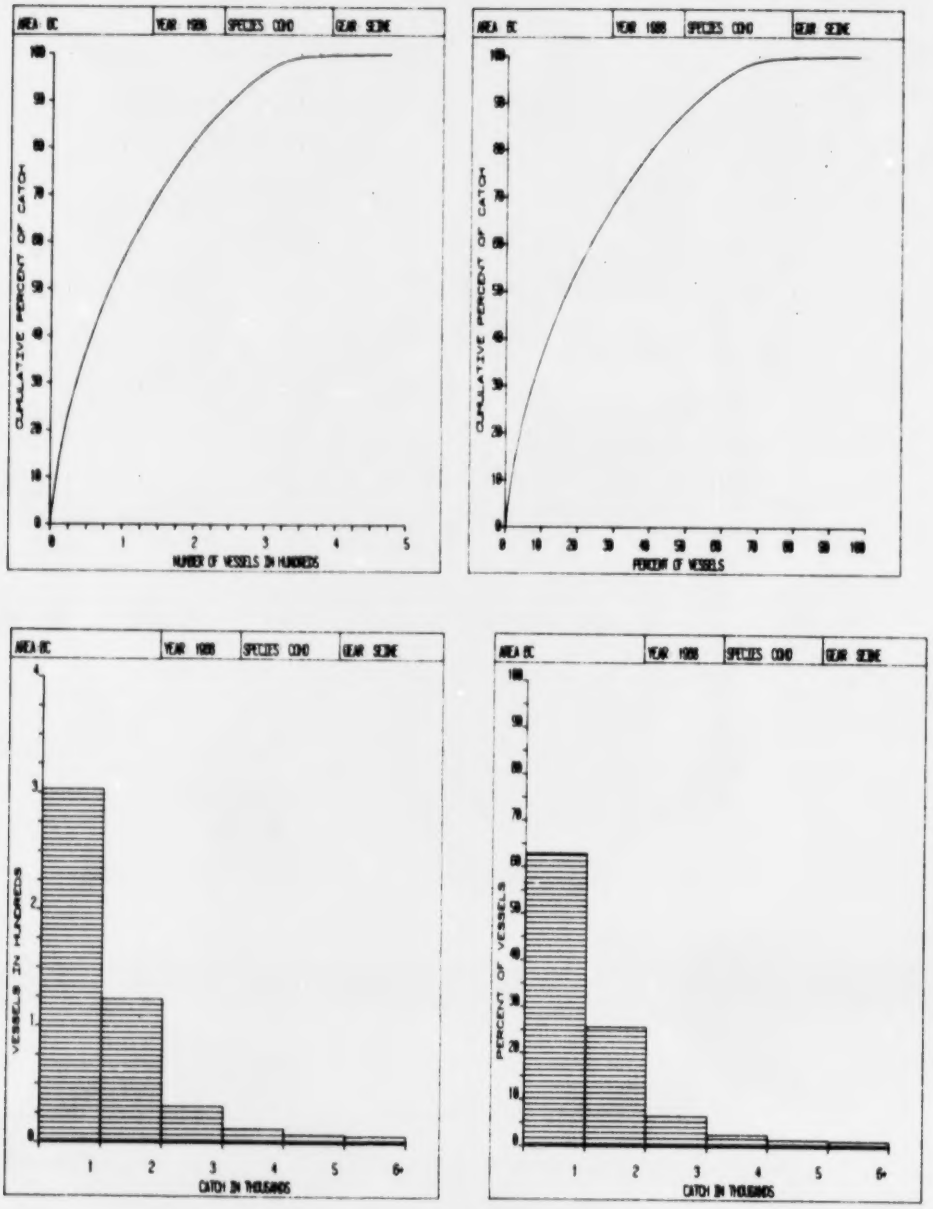


Figure B2. Cumulative percent and frequency of catch of coho salmon versus number and percent of purse seiners that participated in the fishery, 1968.

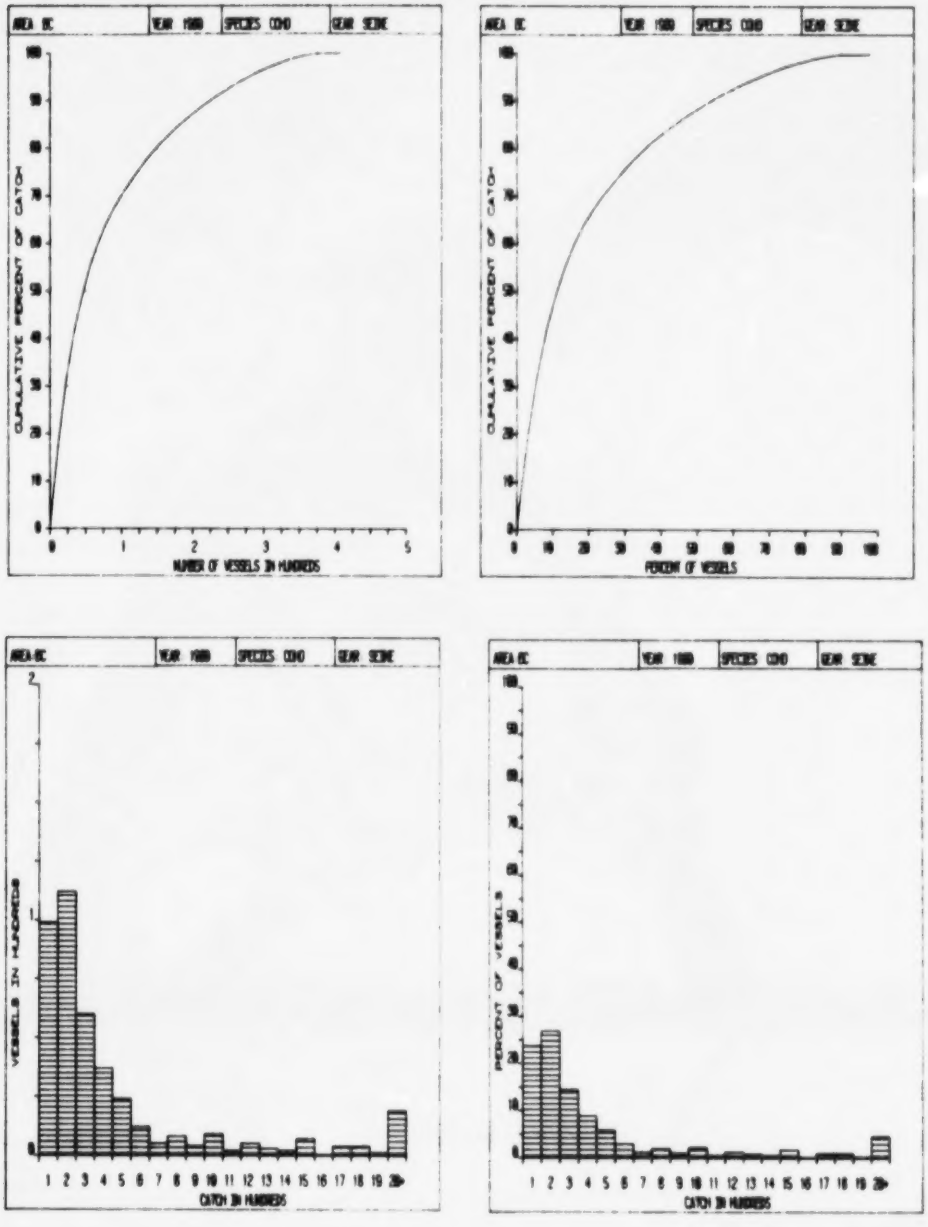


Figure B3. Cumulative percent and frequency of catch of coho salmon versus number and percent of purse seiners that participated in the fishery, 1969.

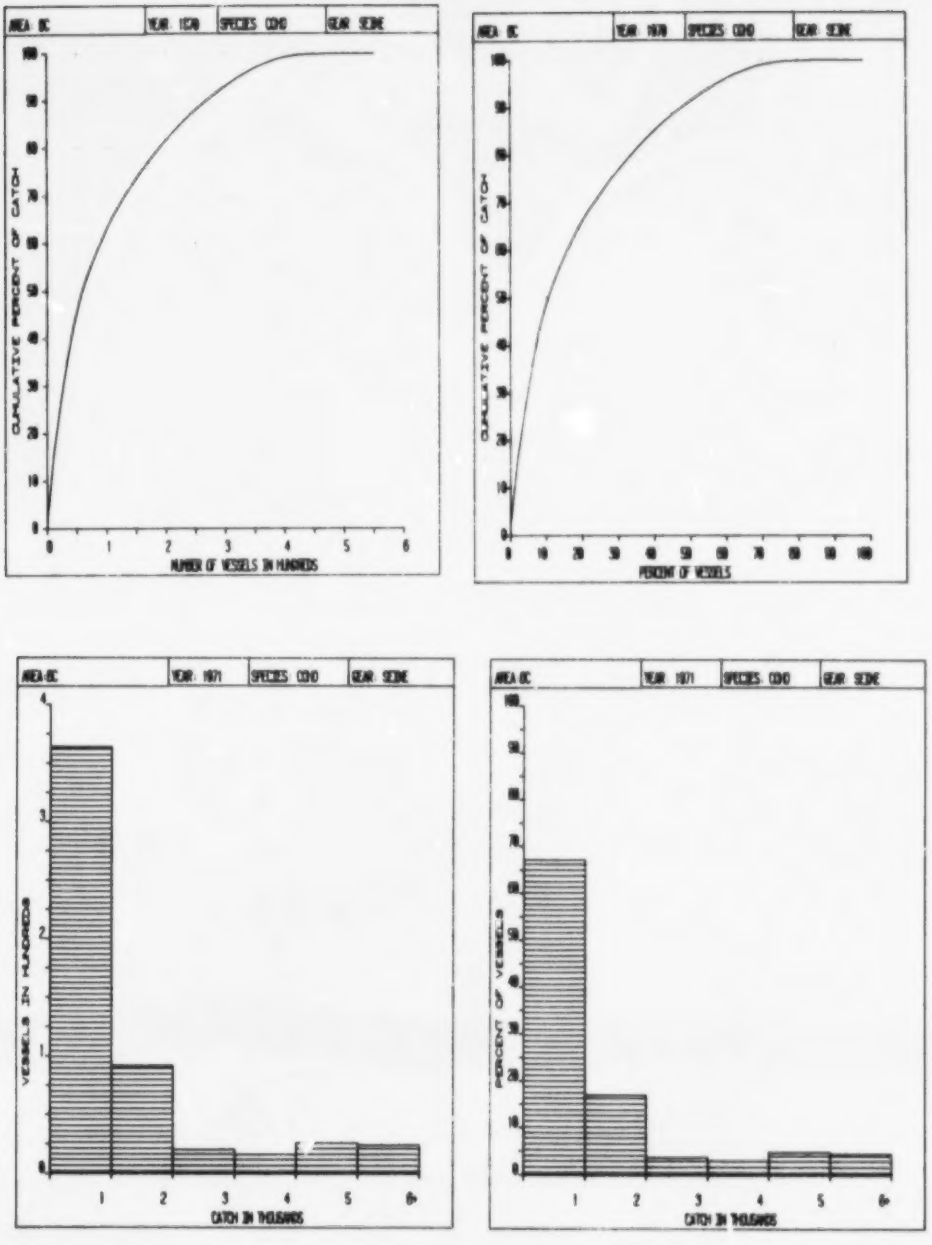


Figure B4. Cumulative percent and frequency of catch of coho salmon versus number and percent of purse seiners that participated in the fishery, 1970.

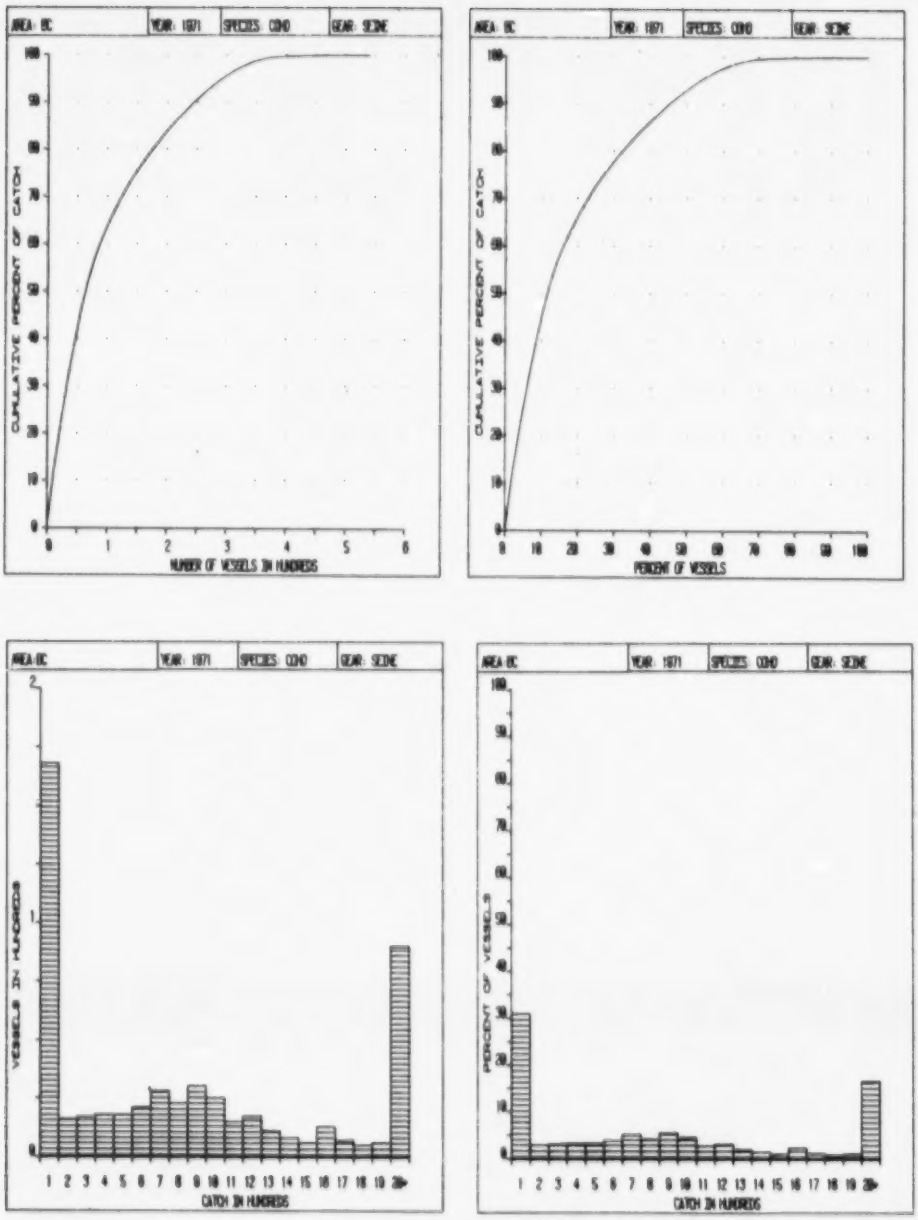


Figure B5. Cumulative percent and frequency of catch of coho salmon versus number and percent of purse seiners that participated in the fishery, 1971.

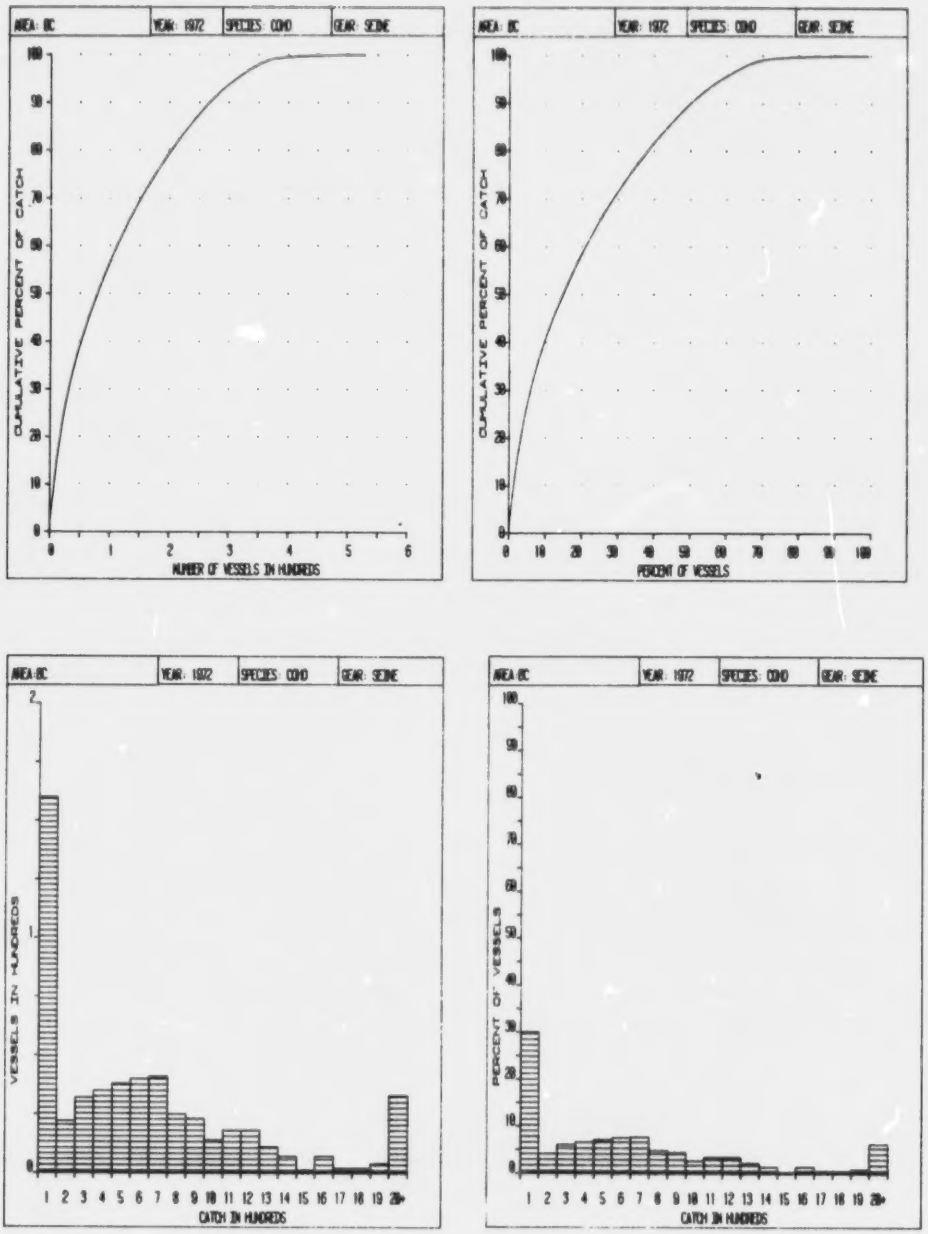


Figure B6. Cumulative percent and frequency of catch of coho salmon versus number and percent of purse seiners that participated in the fishery, 1972.

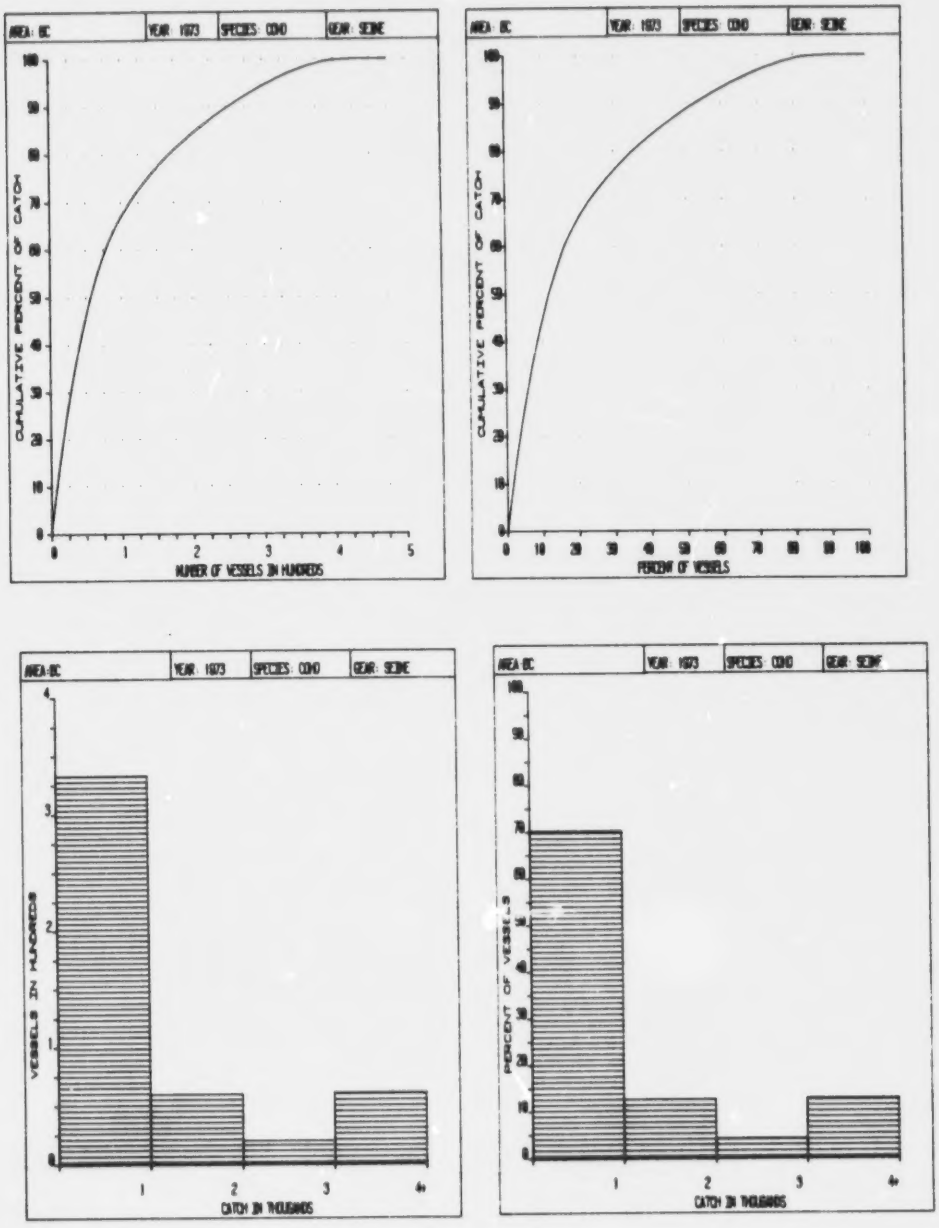


Figure B7. Cumulative percent and frequency of catch of coho salmon versus number and percent of purse seiners that participated in the fishery, 1973.

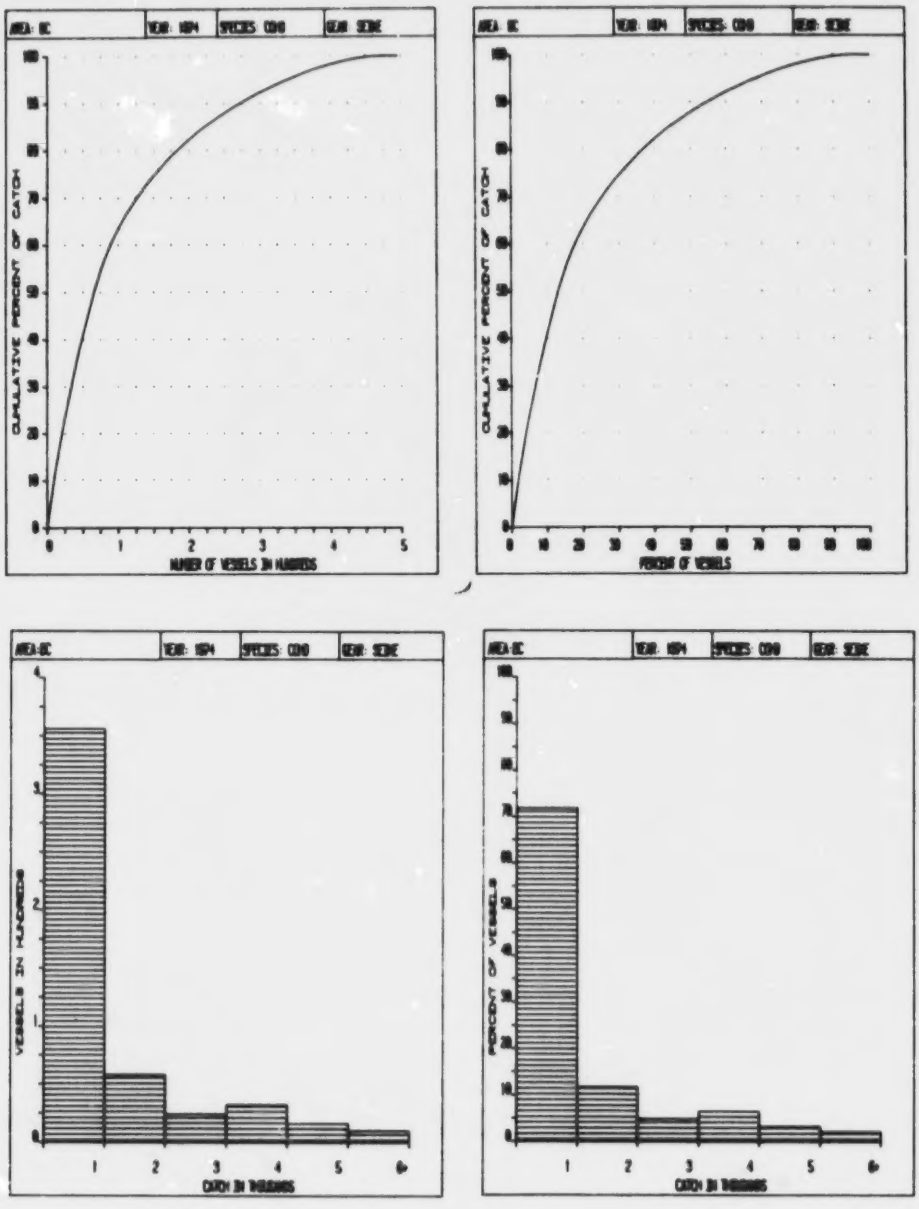


Figure B8. Cumulative percent and frequency of catch of coho salmon versus number and percent of purse seiners that participated in the fishery, 1974.

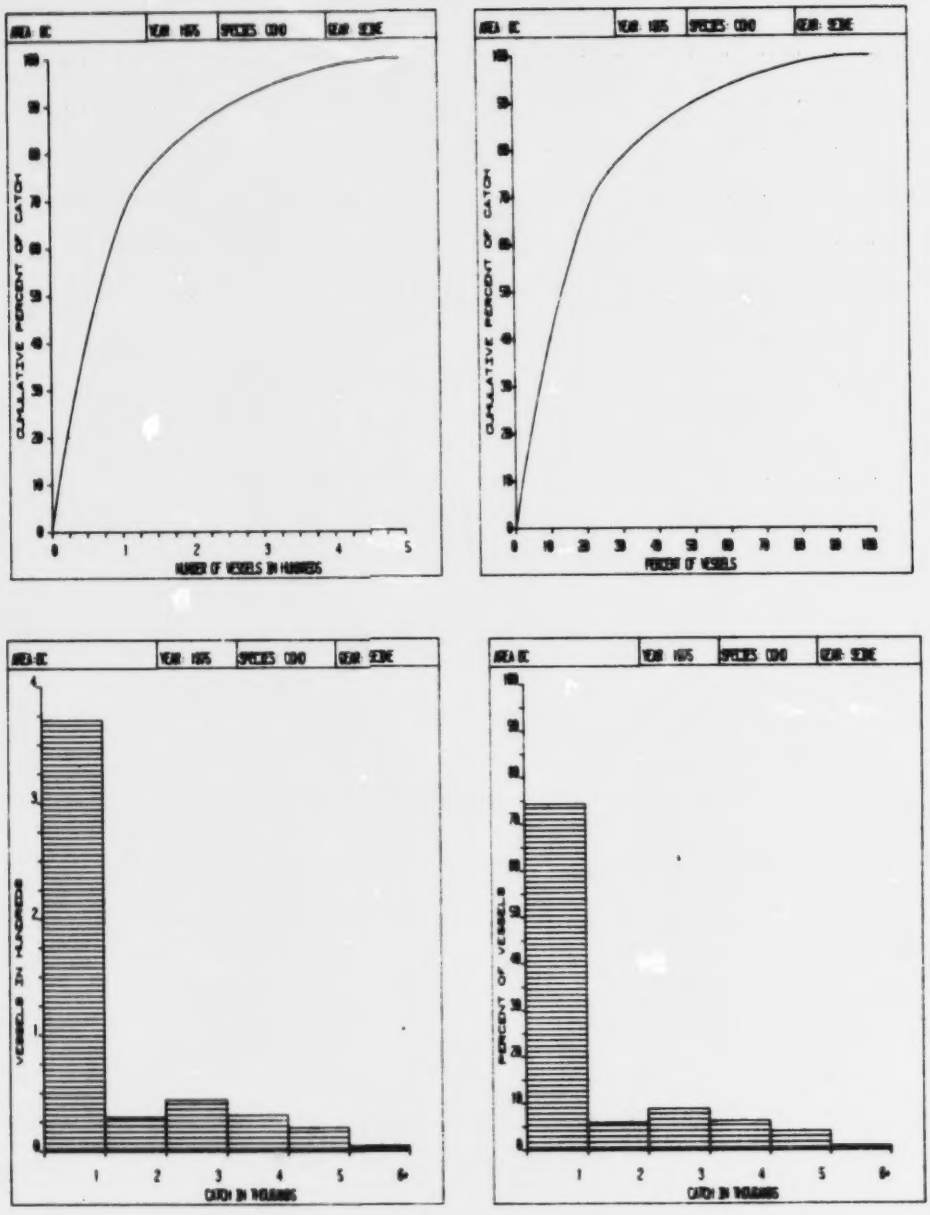


Figure B9. Cumulative percent and frequency of catch of coho salmon versus number and percent of purse seiners that participated in the fishery, 1975.

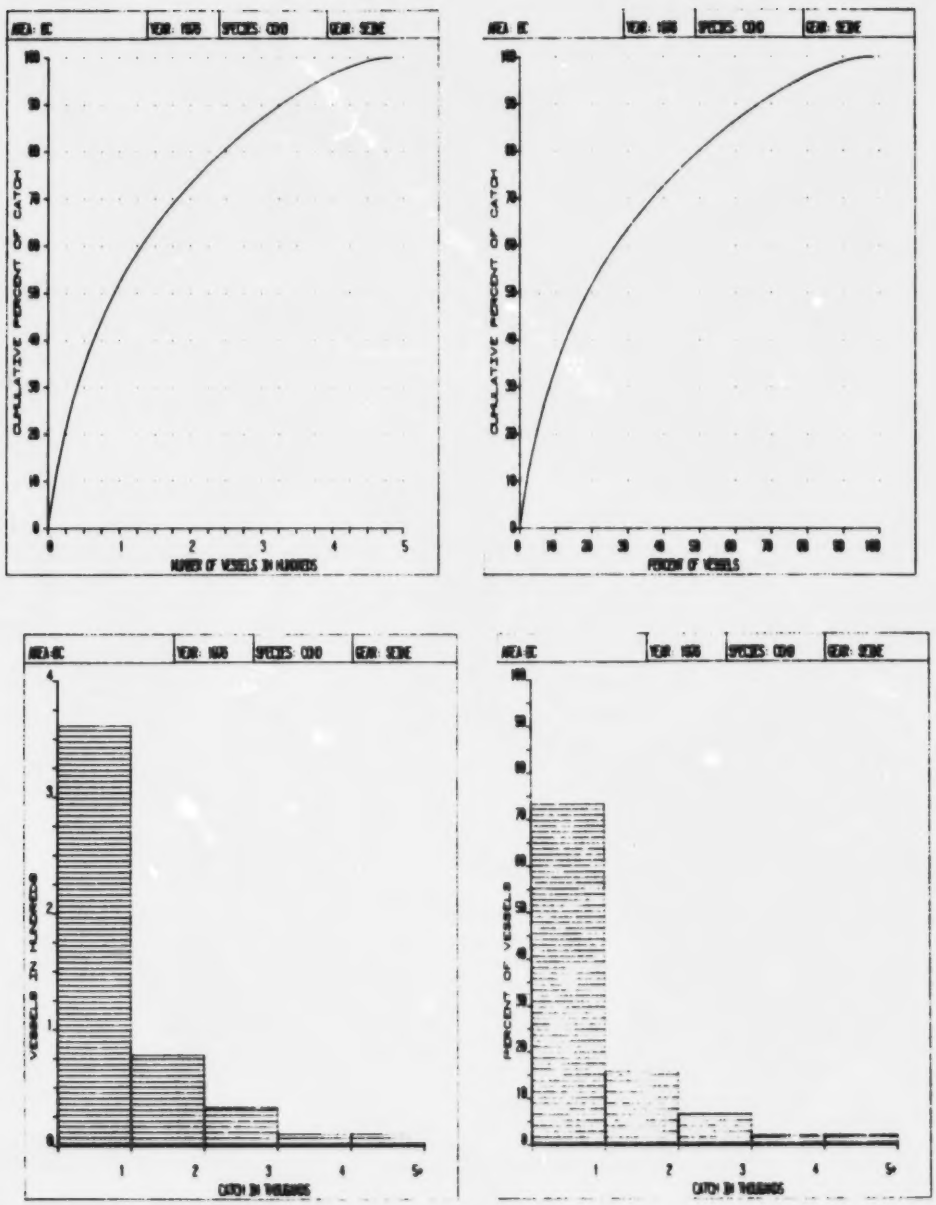


Figure B10. Cumulative percent and frequency of catch of coho salmon versus number and percent of purse seiners that participated in the fishery, 1976.

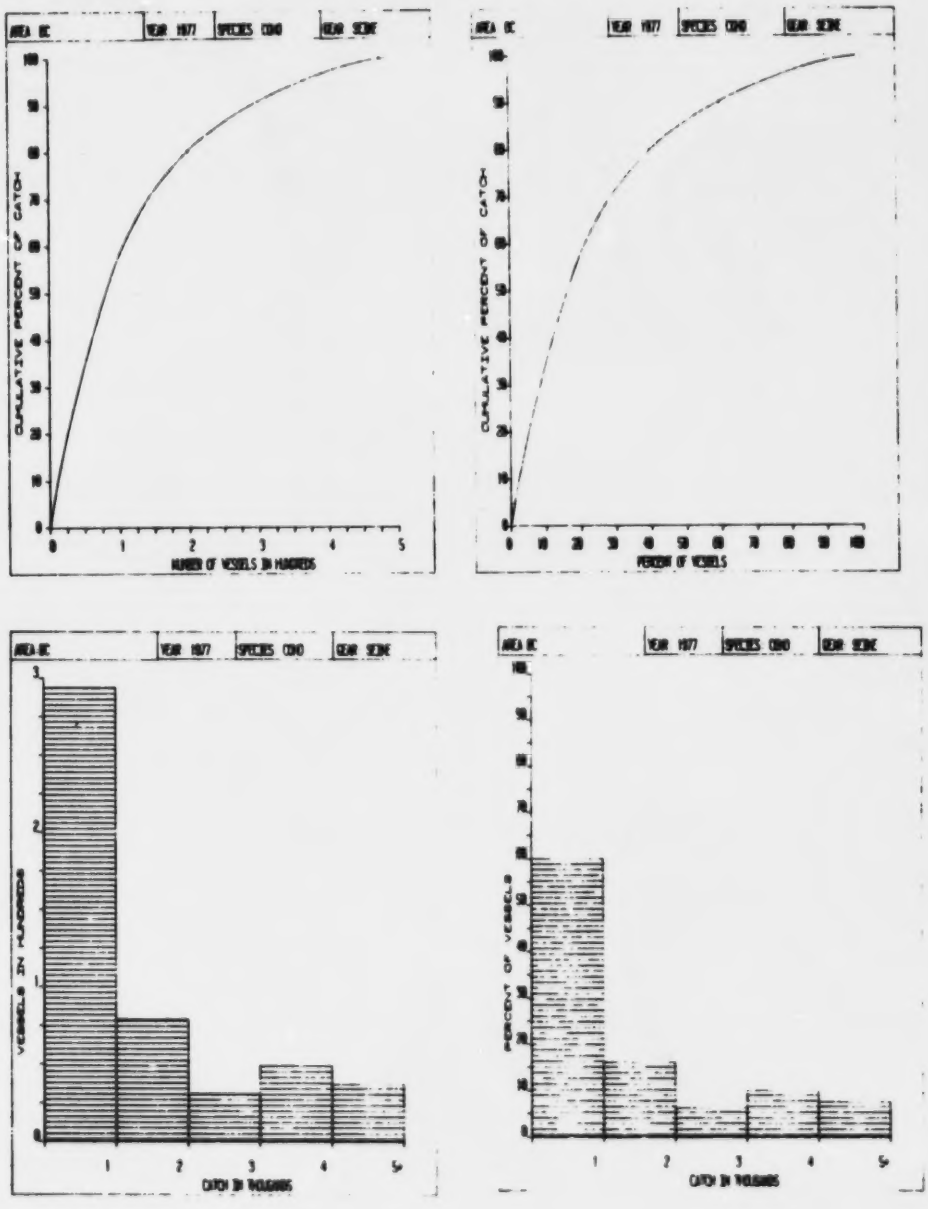


Figure B11. Cumulative percent and frequency of catch of coho salmon versus number and percent of purse seiners that participated in the fishery, 1977.

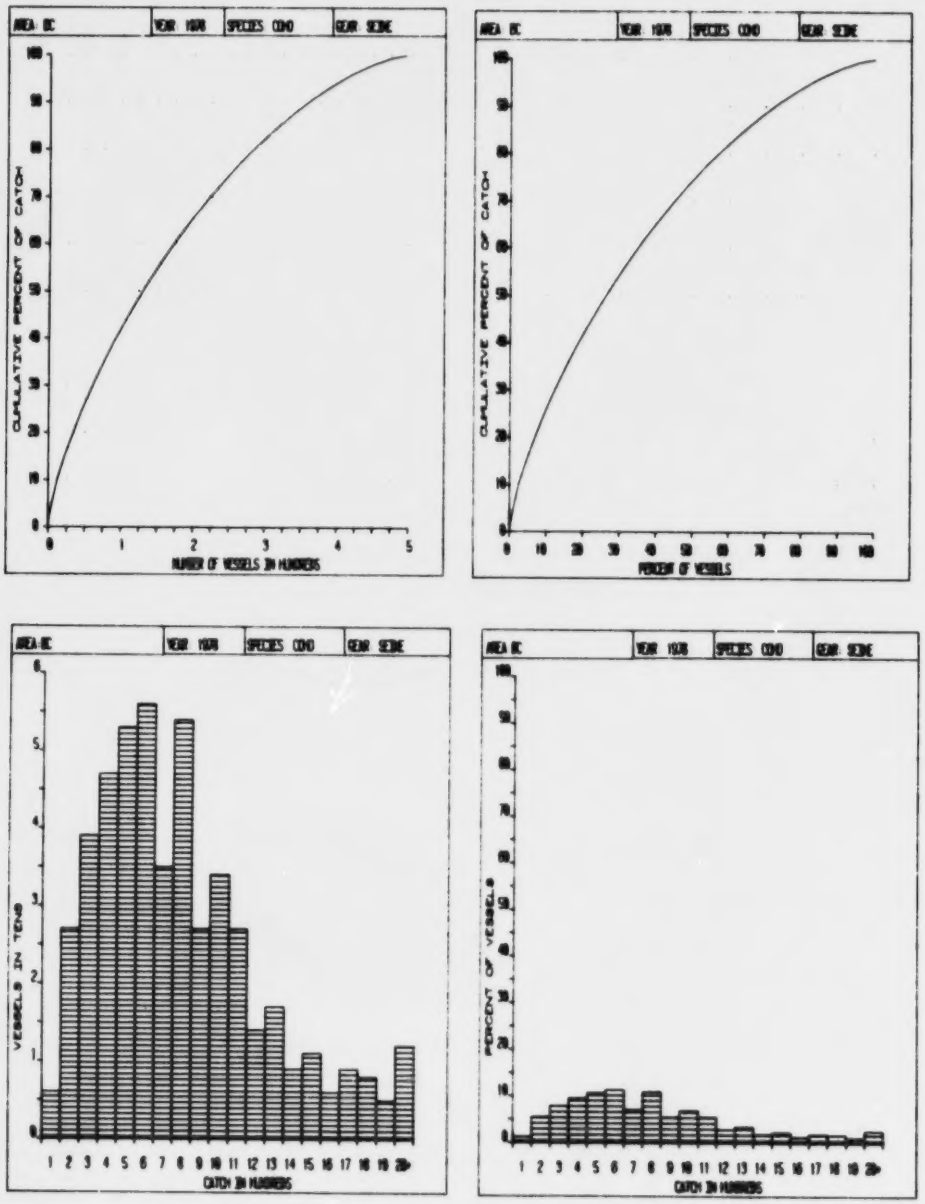


Figure B12. Cumulative percent and frequency of catch of coho salmon versus number and percent of purse seiners that participated in the fishery, 1978.

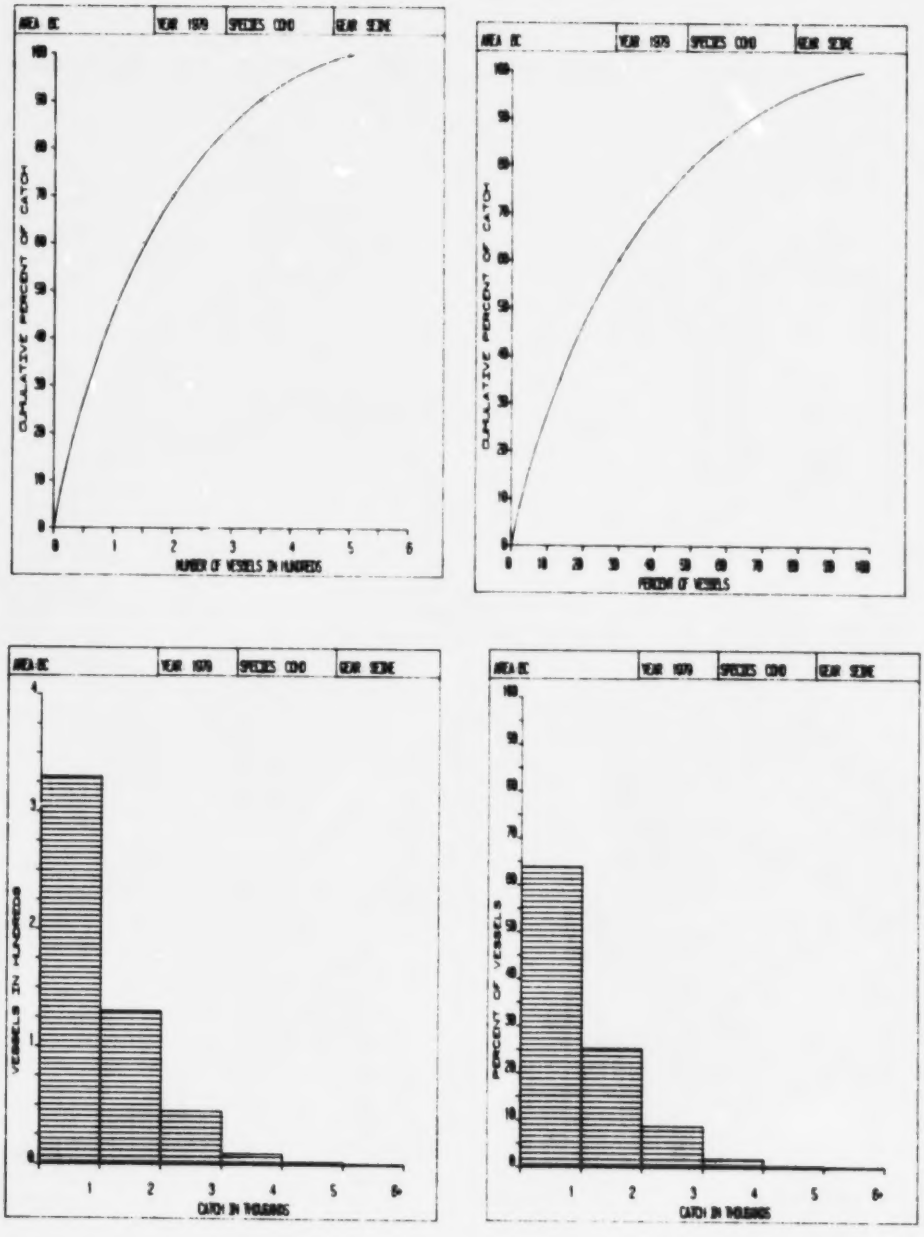


Figure B13. Cumulative percent and frequency of catch of coho salmon versus number and percent of purse seiners that participated in the fishery, 1979.

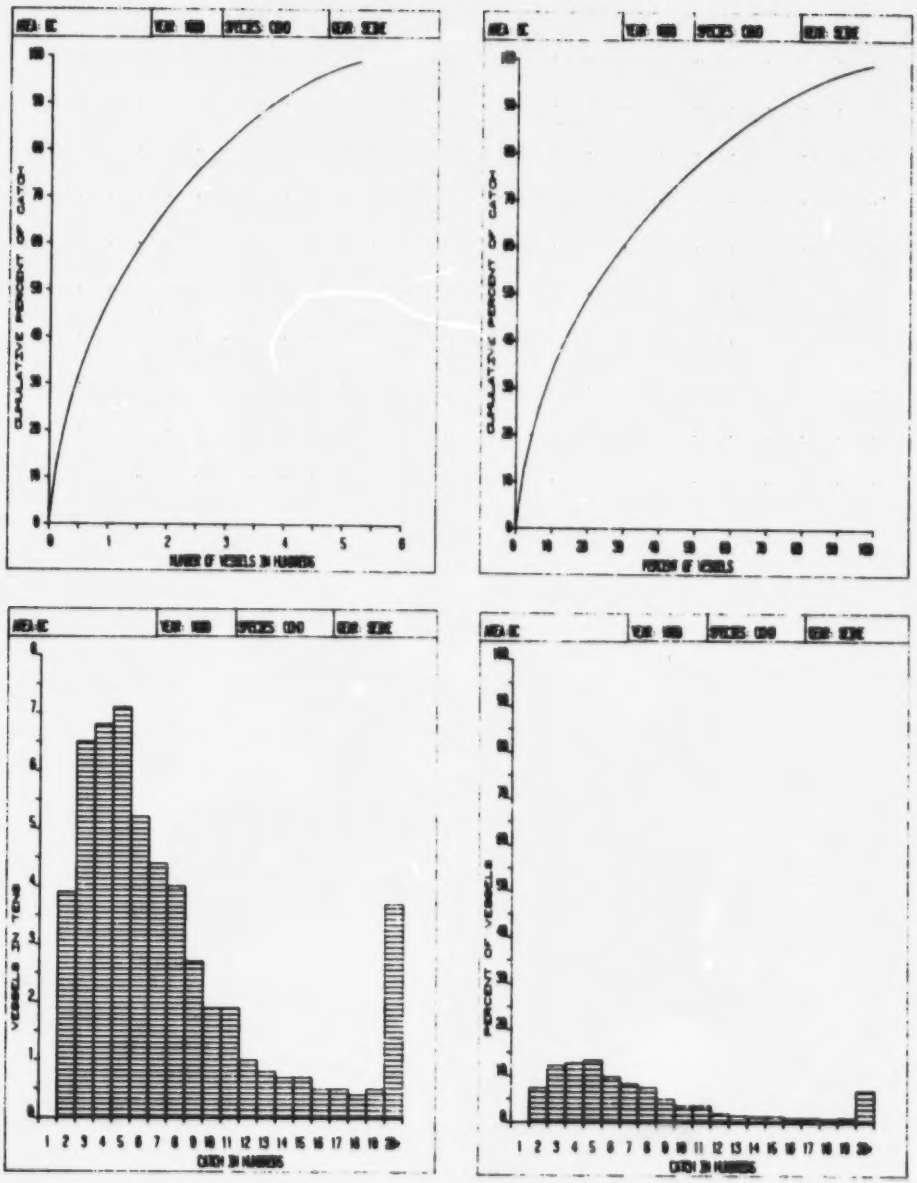


Figure B14. Cumulative percent and frequency of catch of coho salmon versus number and percent of purse seiners that participated in the fishery, 1980.

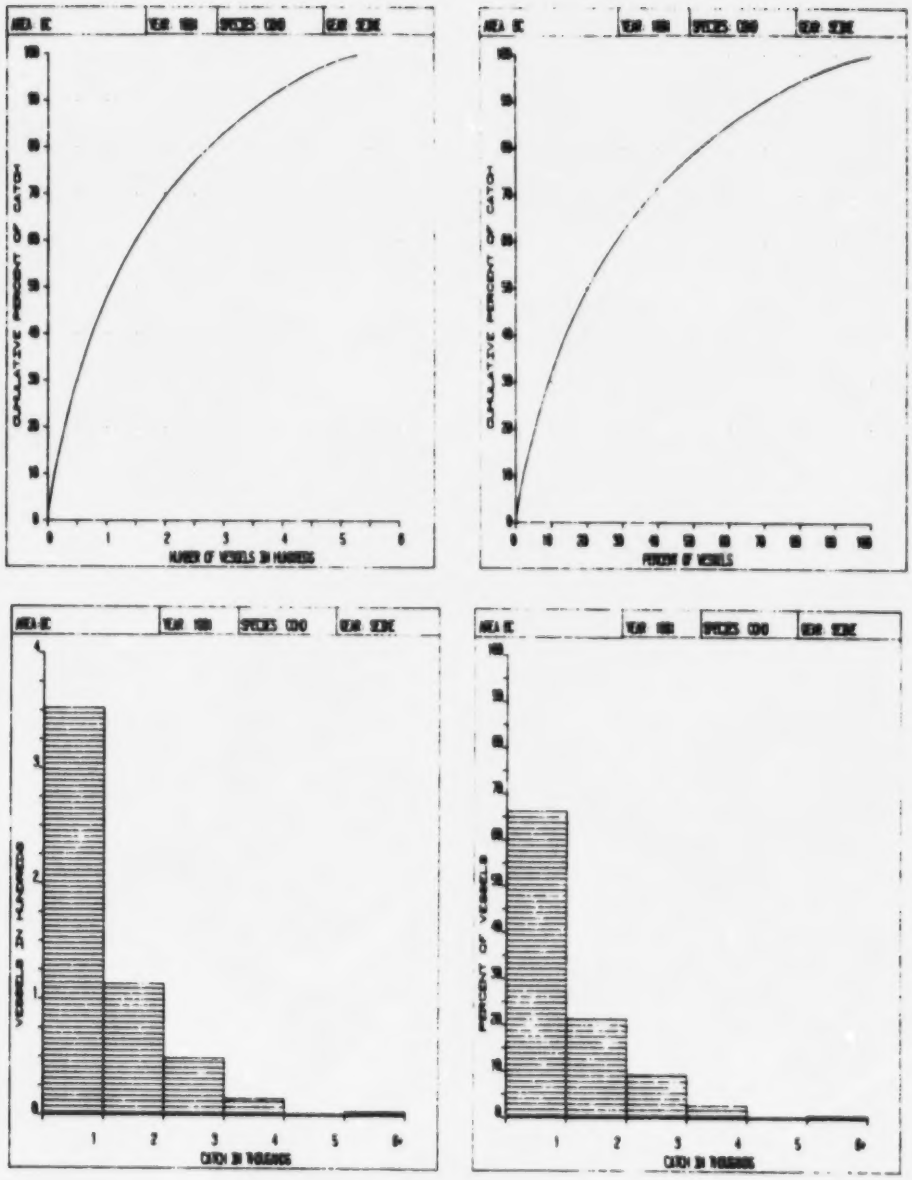


Figure B15. Cumulative percent and frequency of catch of coho salmon versus number and percent of purse seiners that participated in the fishery, 1981.

APPENDIX C

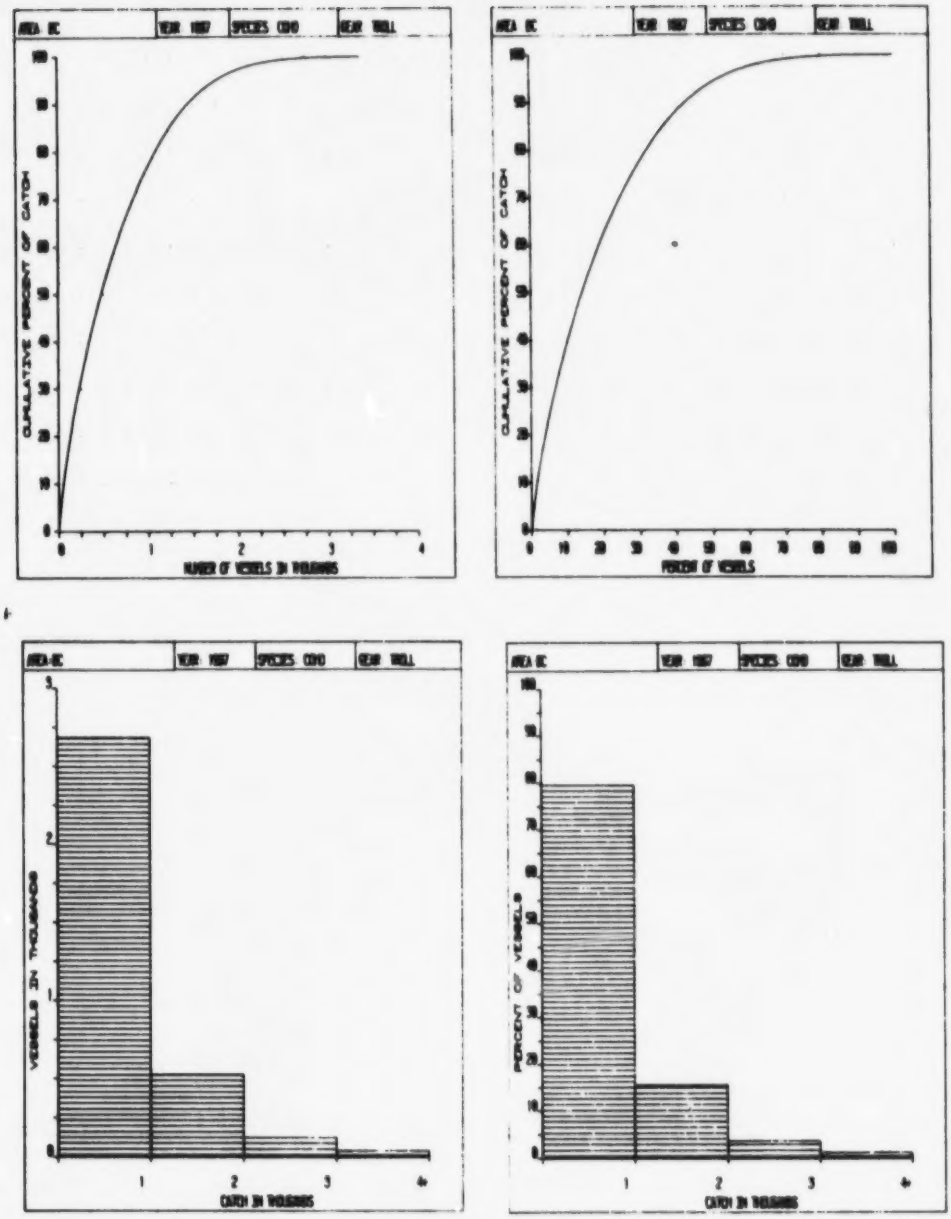


Figure C1. Cumulative percent and frequency of catch of coho salmon versus number and percent of vessels that used troll gear and participated in the fishery, 1967.

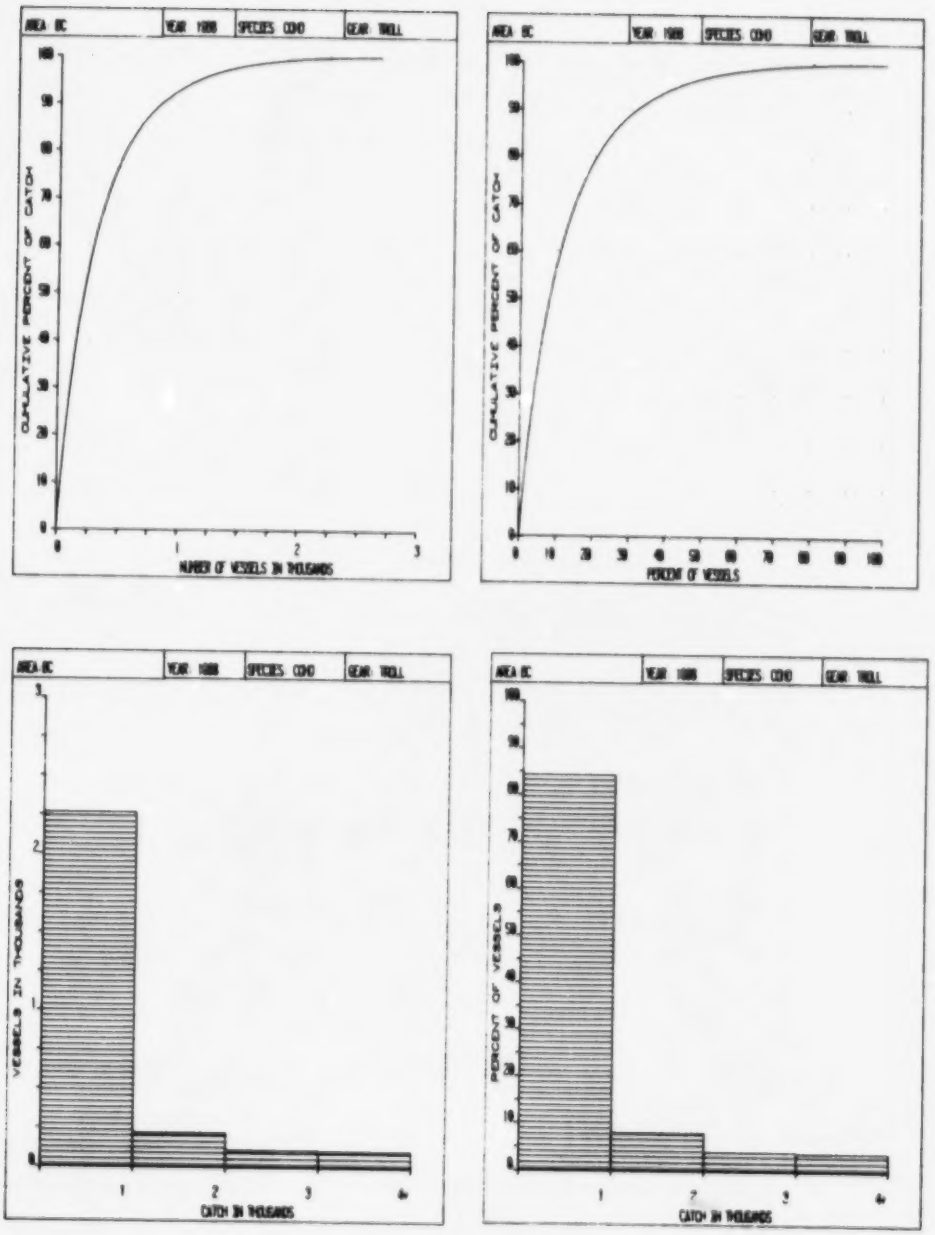


Figure C2. Cumulative percent and frequency of catch of coho salmon versus number and percent of vessels that used troll gear and participated in the fishery, 1968.

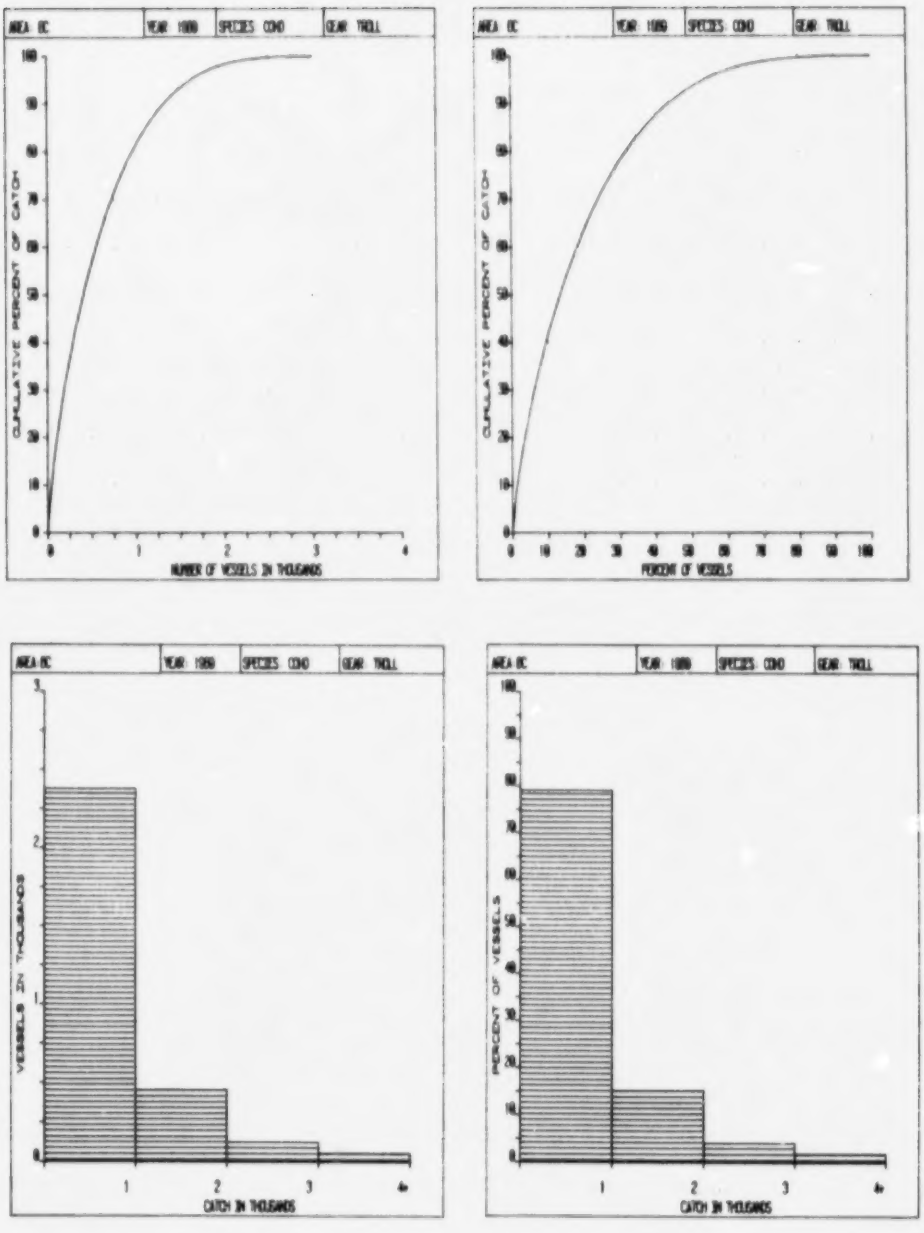


Figure C3. Cumulative percent and frequency of catch of coho salmon versus number and percent of vessels that used troll gear and participated in the fishery, 1969.

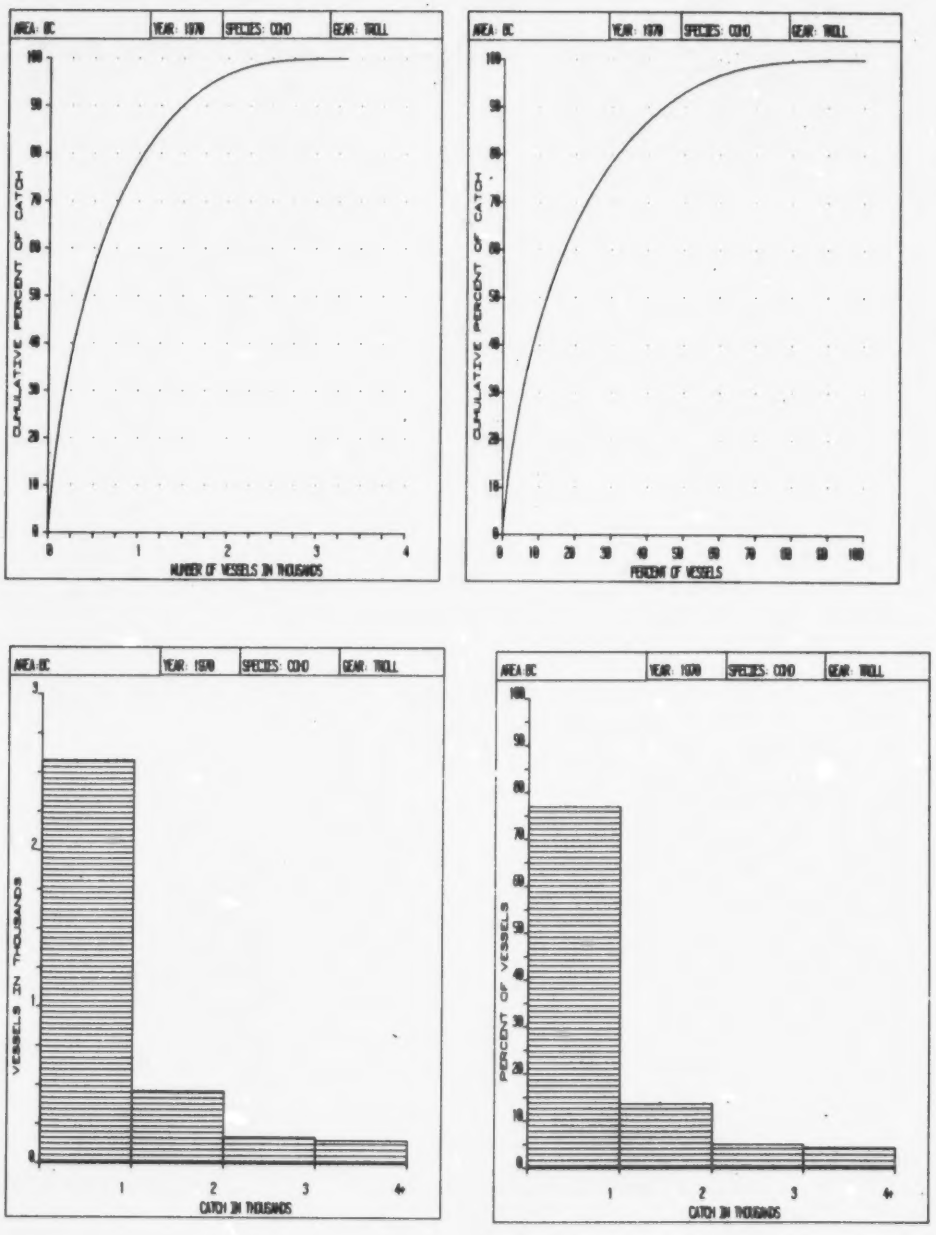


Figure C4. Cumulative percent and frequency of catch of coho salmon versus number and percent of vessels that used troll gear and participated in the fishery, 1970.

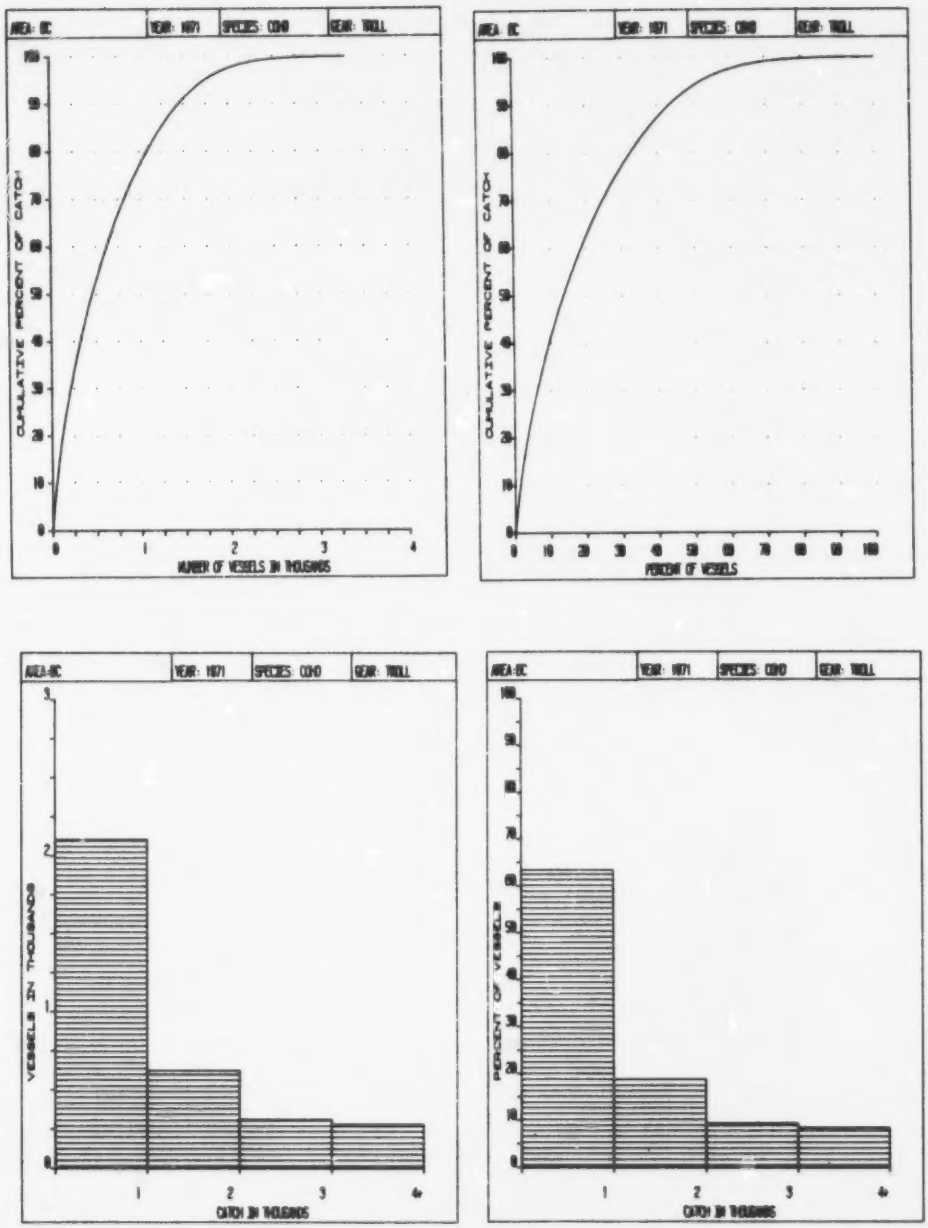


Figure C5. Cumulative percent and frequency of catch of coho salmon versus number and percent of vessels that used troll gear and participated in the fishery, 1971.

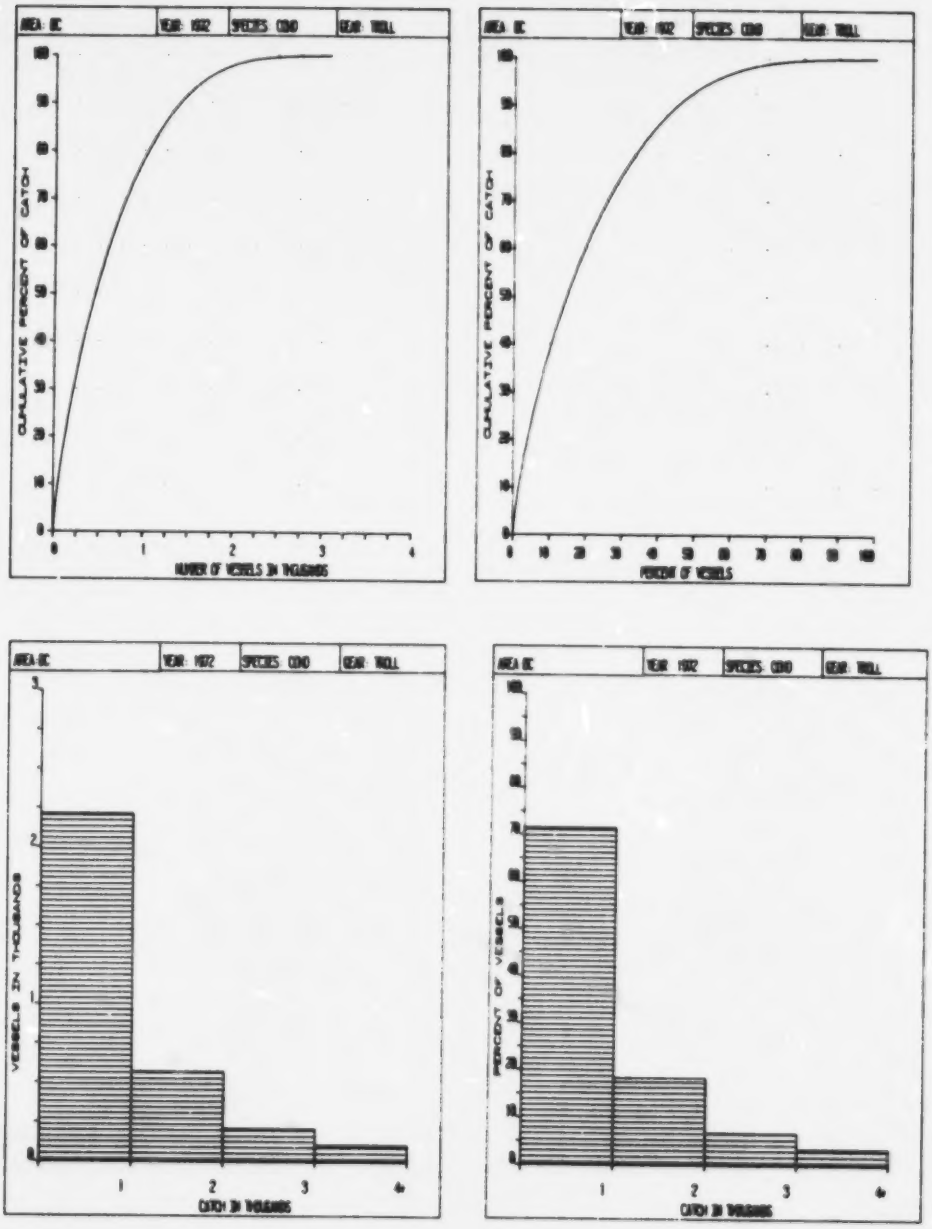


Figure C6. Cumulative percent and frequency of catch of coho salmon versus number and percent of vessels that used troll gear and participated in the fishery, 1972.

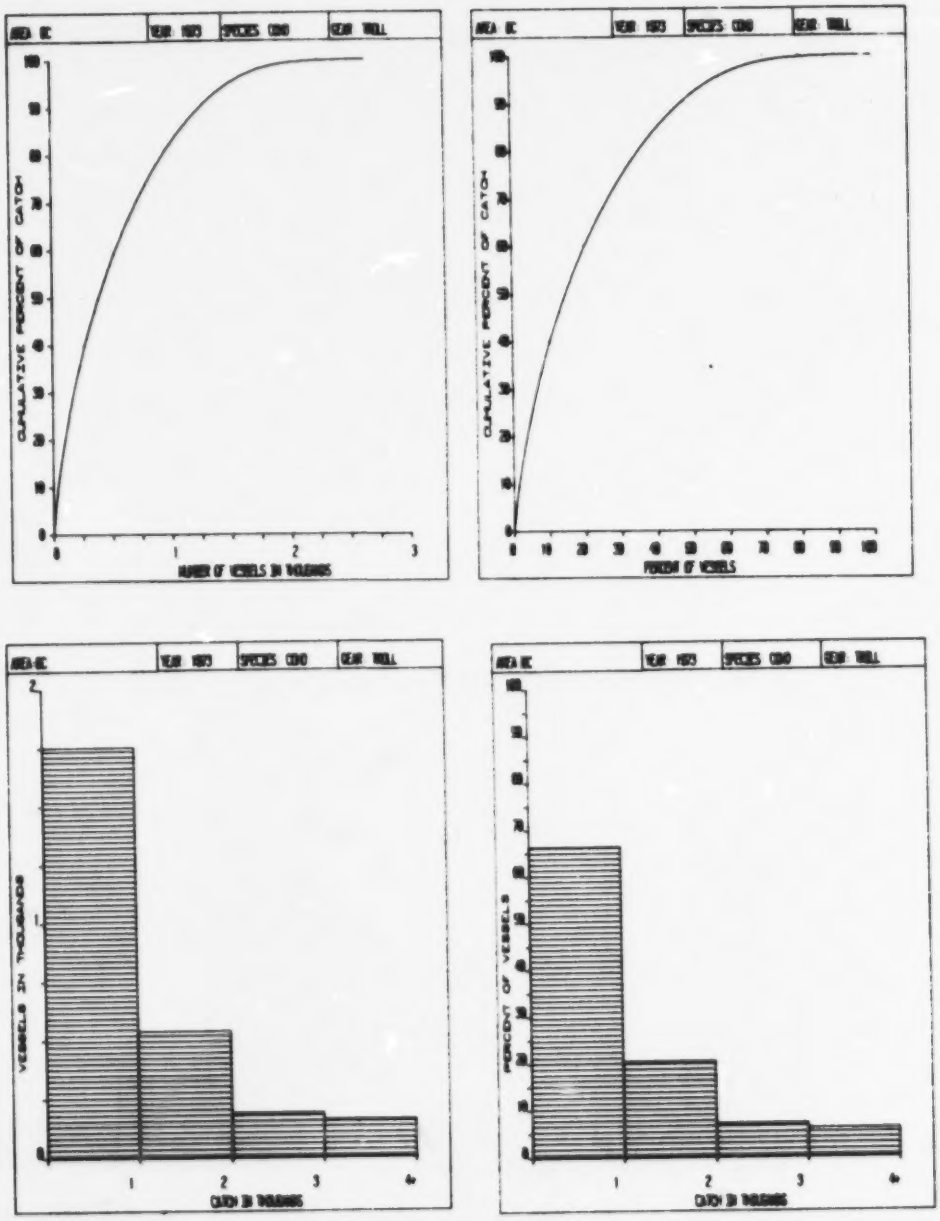


Figure C7. Cumulative percent and frequency of catch of coho salmon versus number and percent of vessels that used troll gear and participated in the fishery, 1973.

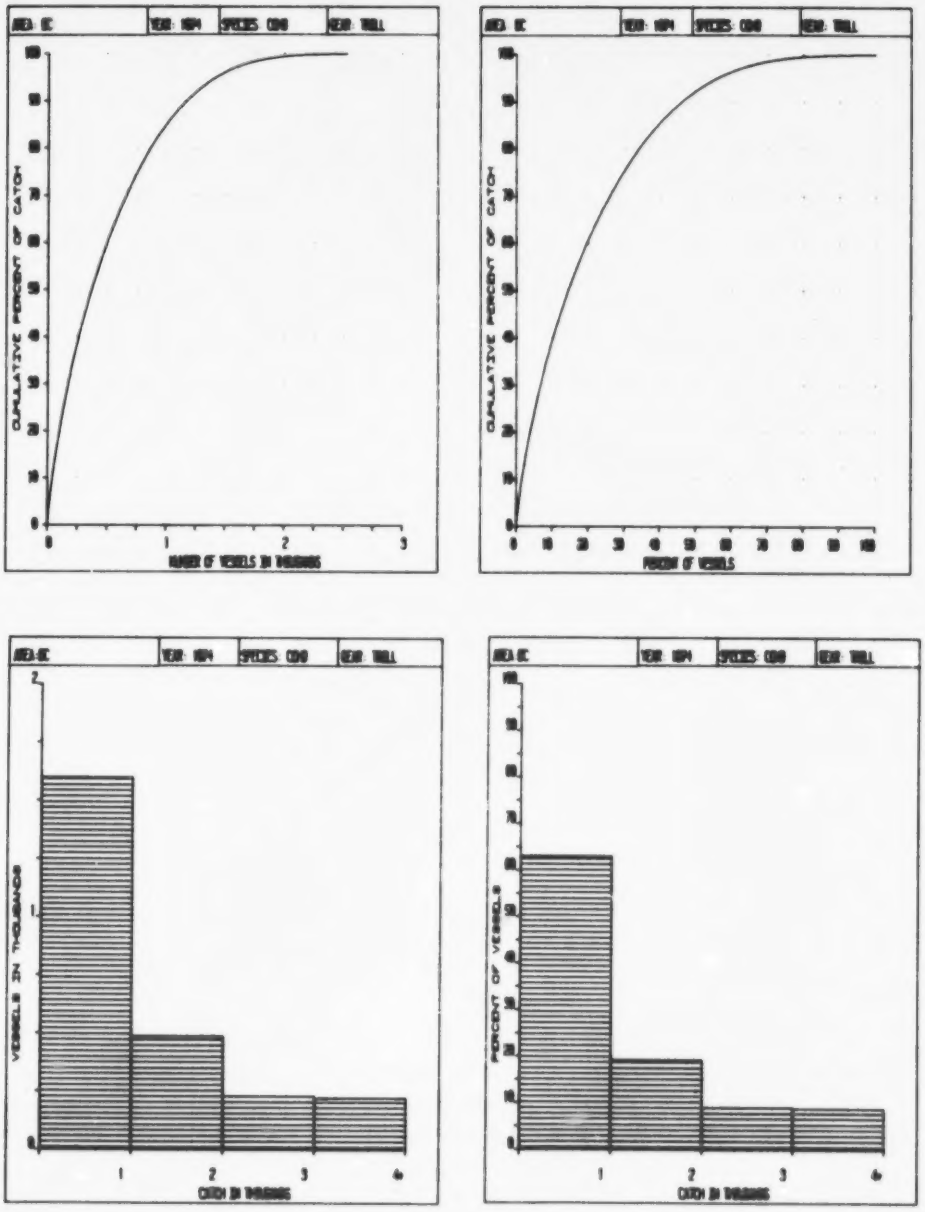


Figure C8. Cumulative percent and frequency of catch of coho salmon versus number and percent of vessels that used troll gear and participated in the fishery, 1974.

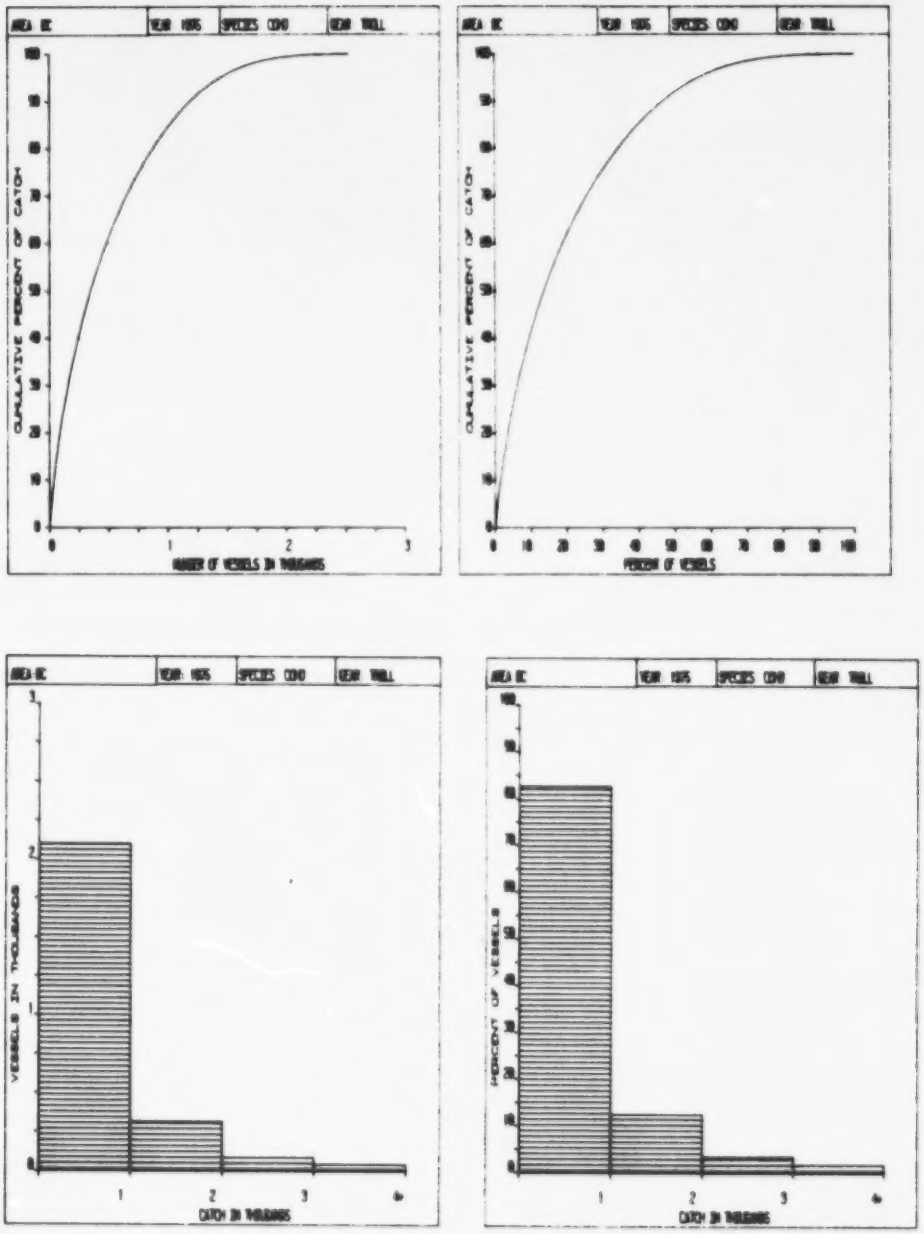


Figure C9. Cumulative percent and frequency of catch of coho salmon versus number and percent of vessels that used troll gear and participated in the fishery, 1975.

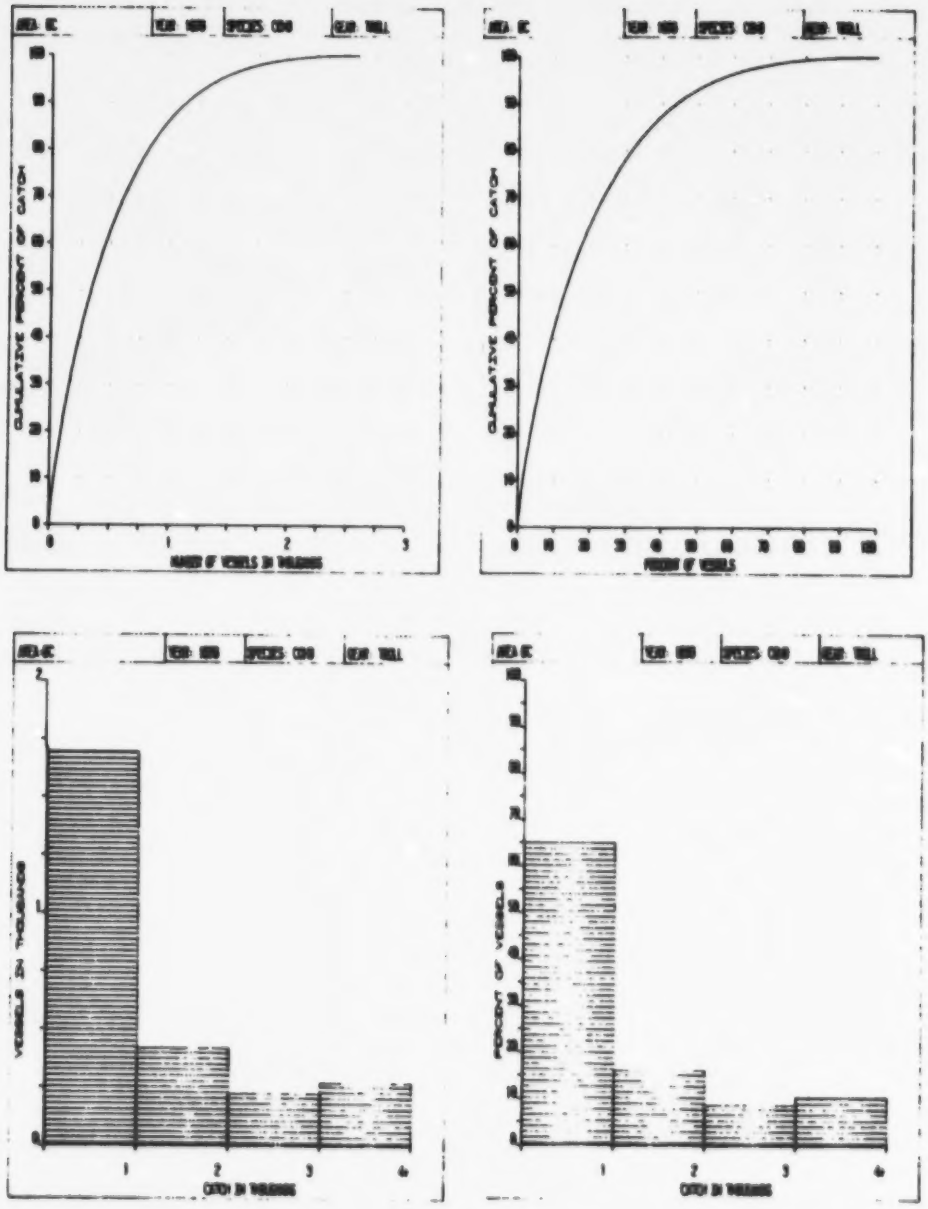


Figure C10. Cumulative percent and frequency of catch of coho salmon versus number and percent of vessels that used troll gear and participated in the fishery, 1976.

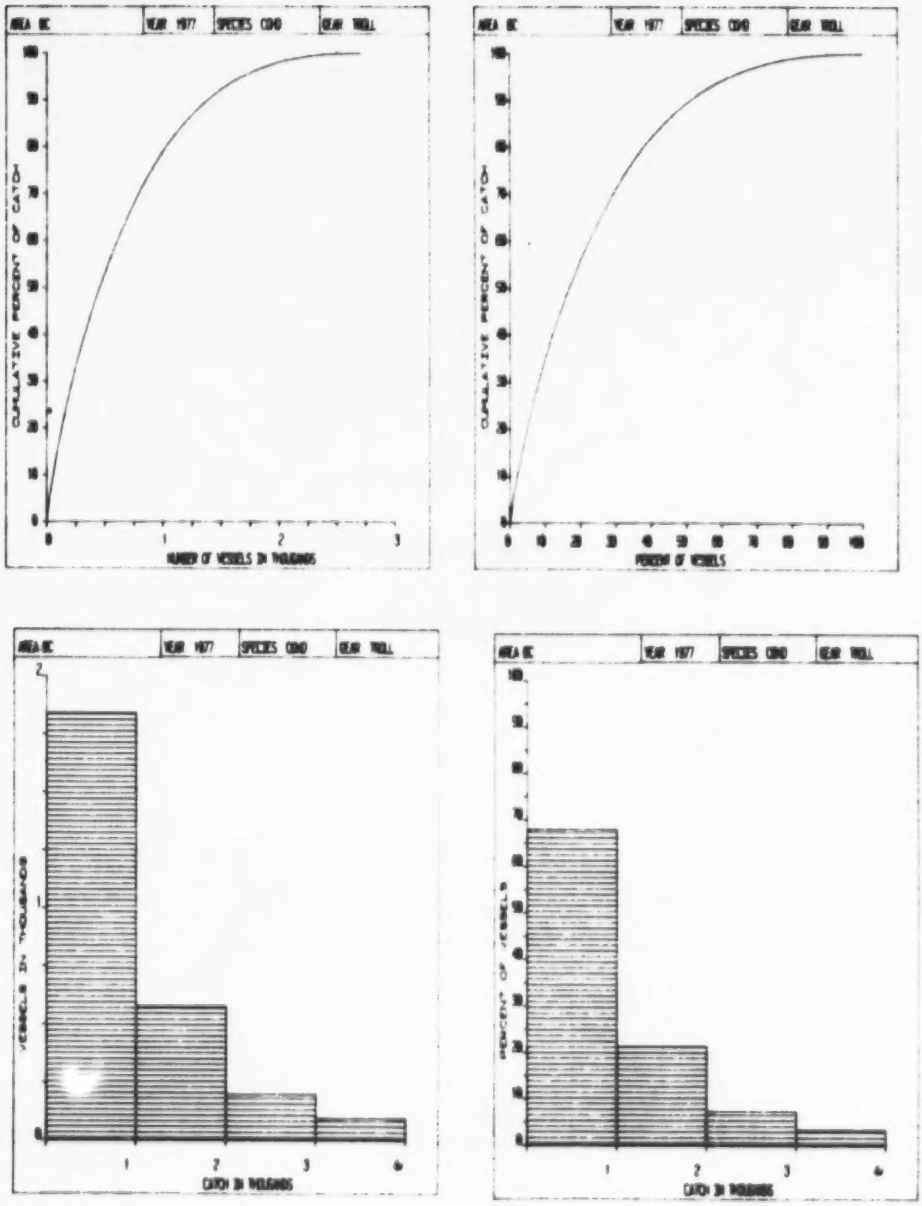
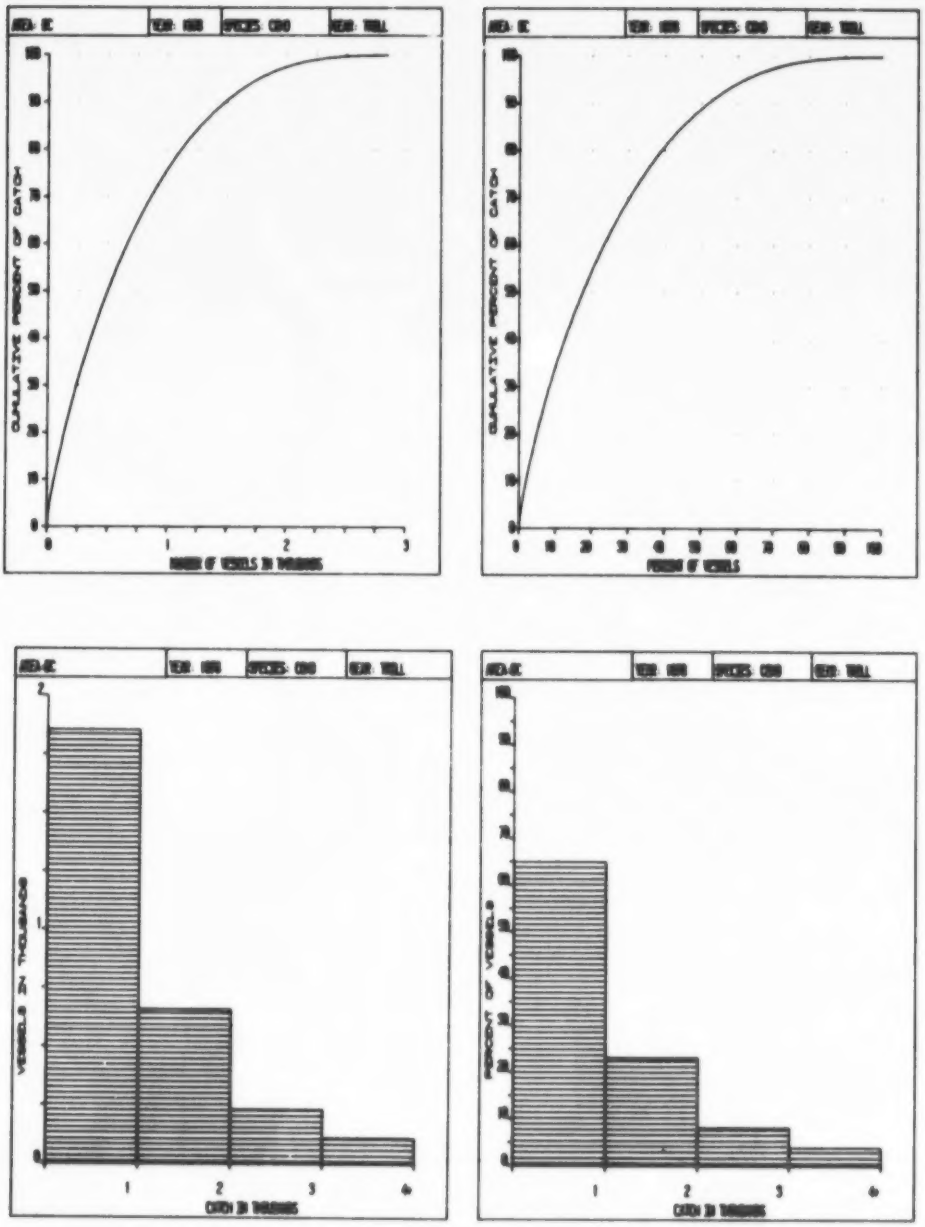


Figure C11. Cumulative percent and frequency of catch of coho salmon versus number and percent of vessels that used troll gear and participated in the fishery, 1977.



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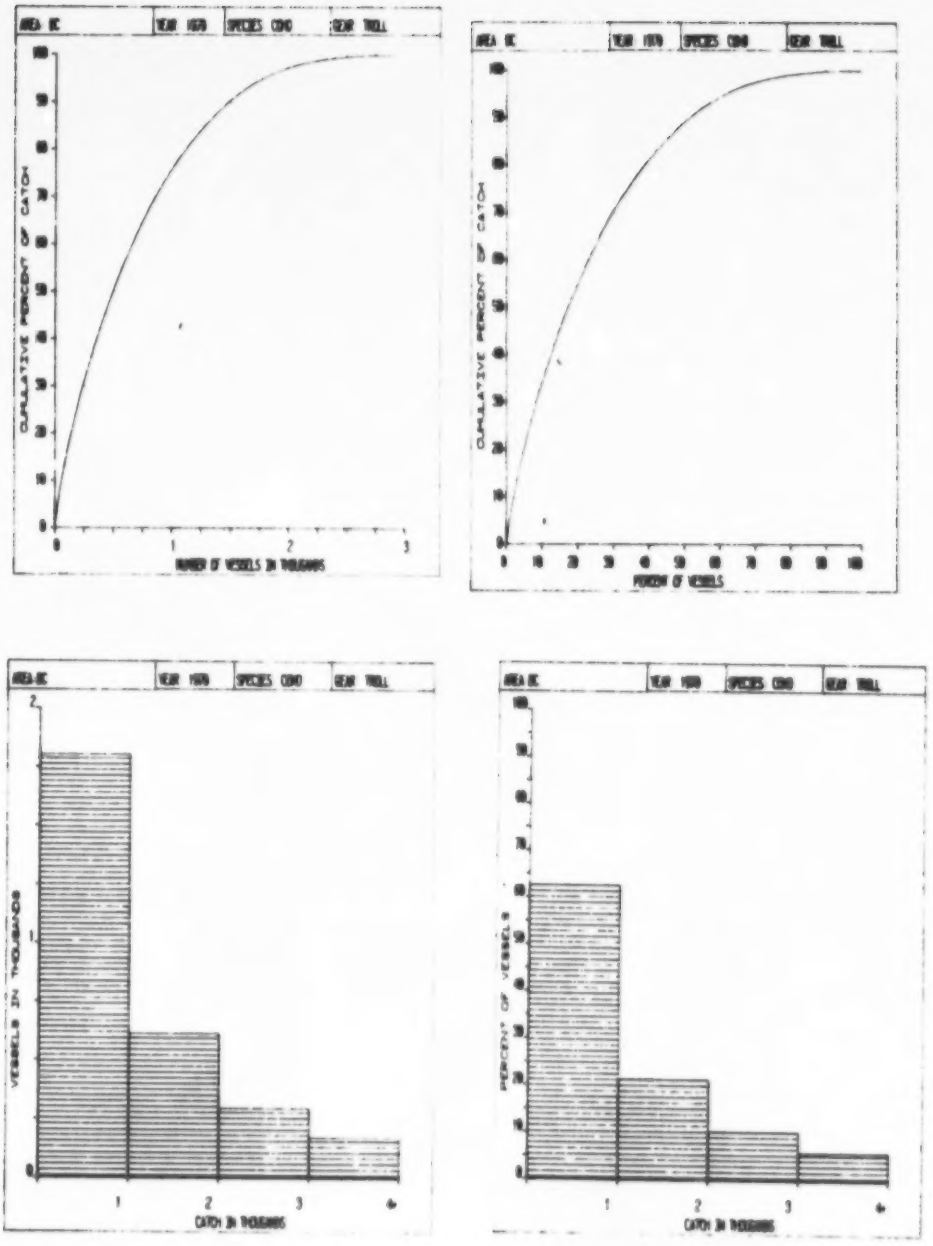

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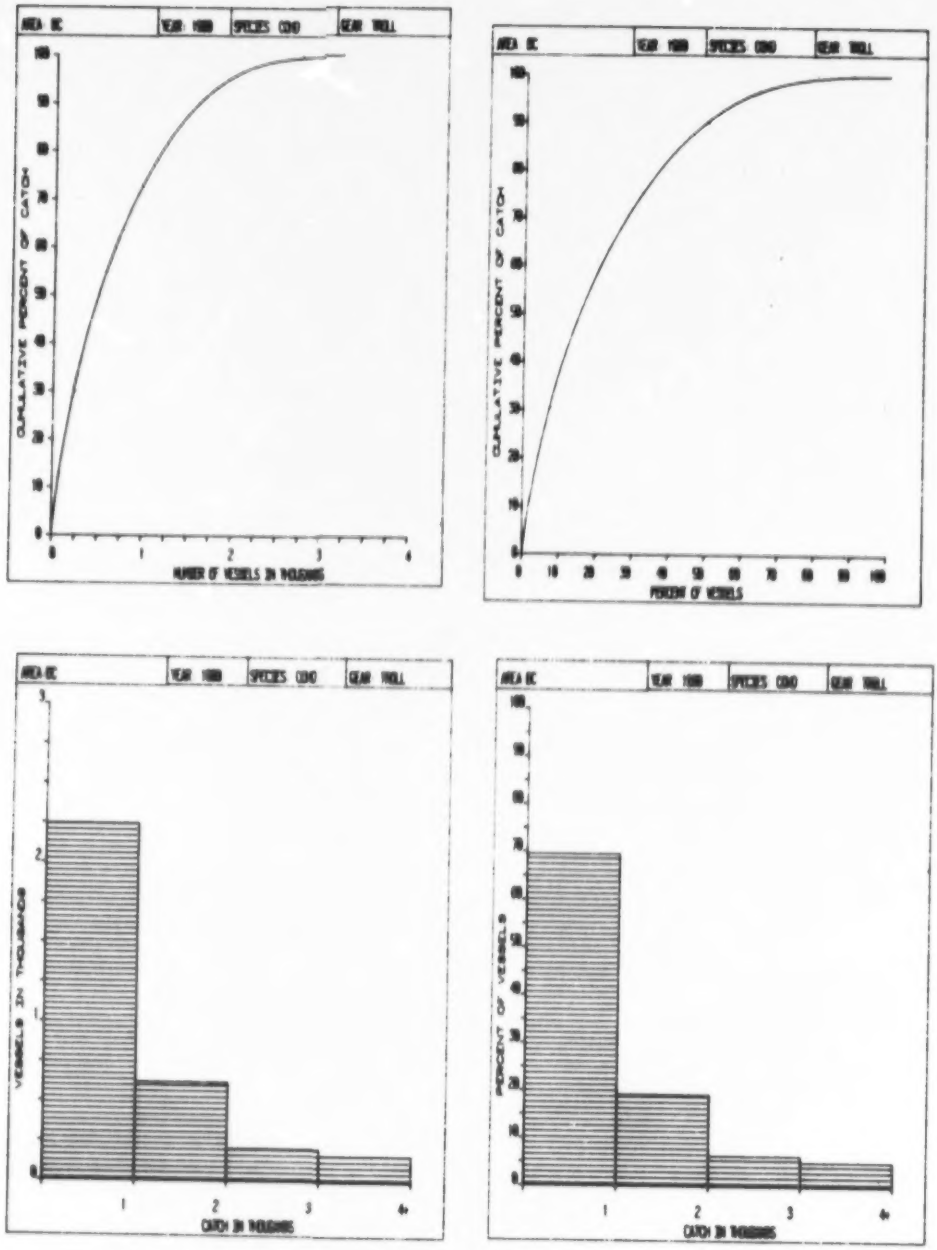

Figure C14. Cumulative percent and frequency of catch of coho salmon versus number and percent of vessels that used troll gear and participated in the fishery, 1980.

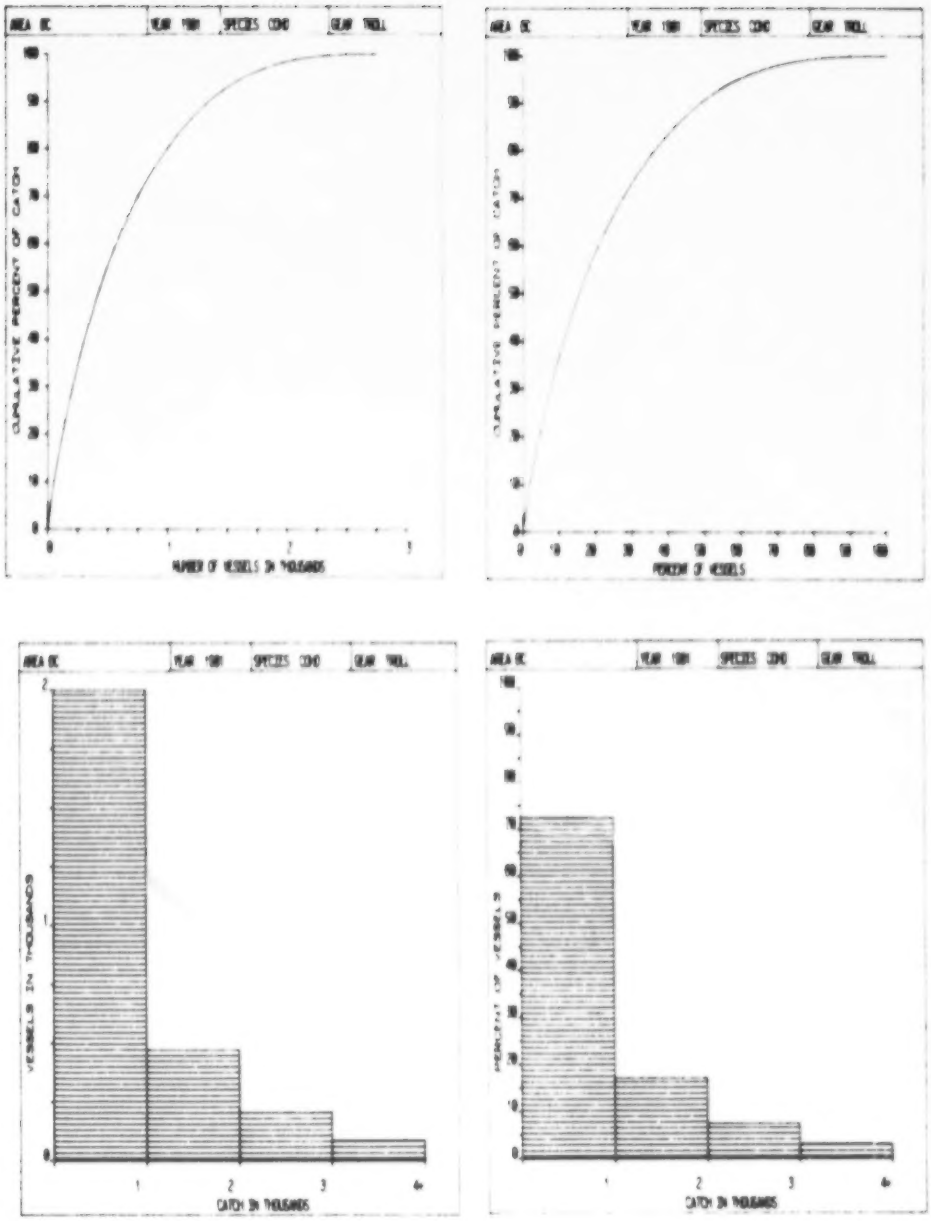

Figure C15. Cumulative percent and frequency of catch of coho salmon versus number and percent of vessels that used troll gear and participated in the fishery, 1981.